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The Chenoweth method of constructing monolithic or jointless sewers, conduits, etc., out of concrete by the use of spiral steel centering, which was described in Engineering News, Oct. 17, 1891, has been awarded by the Franklin Institute the Edward Longstreth silver medal of merit. The report of the committee of the Institute to whom the investigation of this novel method was referred, after calling attention to certain features of the inventions, concludes as follows: "It is our opinion that this method represents an advance in the construction of such engineering works as drains, sewers and the like, making it possible to produce better work at lower cost. In recognition of which, we believe the inventor entitled to the award of the Edward Longstreth Medal of Merit." The committee consisted of Edward F. Moody, C. John Hexamer, Reuben Haines, Samuel P. Stadtler and Rudolph Hering. Mr. A. Crawford Chenoweth, is engineer in charge of the Croton Aqueduct.

A water pressure pump, for forcing water to the upper floors of city houses, or utilizing city water pressure to pump from cisterns, wells or other sources, is being introduced by the Erwin-Welch Hydraulic Machinery Co., of Chicago. The pump cylinder and pressure cylinder are in line with each other, and the valves are moved by a tappet gear. Such a machine should be of great value wherever an ample supply of water under a low head is available and a supply at a higher pressure or greater elevation is desired. It is unfortunately the case, however, that in most cases where the pressure of the city supply is not sufficient to force water to the upper stories of buildings the fault is either that the supply is unequal to the demand or the distributing mains are too small to keep up the pressure. In either of these cases the use of hydraulic pumps of this class will naturally be forbidden, unless accompanied with proper arrangements for utilizing all the exhaust water from the pump for the supply of the lower stories.

An irrigating device has been invented by Mr. B. D. Owen, of Texas. It is a boat, or other float, supporting a pump operated by an undershot water-wheel attached to the rear of the float. This boat is to be anchored at any point in the ditch from which water is to be taken, the pumping being done solely by the current when this is strong enough. A movable cover over the wheel protects it from injurious wind action.

A wire wound gun on the system of Dr. W. E. Woodbridge is being made in Boston. The inner tube is made of steel and is 27½ ft. long, and eventually will have a bore of 12½ ins. The wire is square in section, 15-100 in. thick, and is said to have a tensile strength of 200,000 lbs. per sq. in. It is wound under great stress, and the inventor says it would require an internal pressure exceeding 80,000 lbs. per sq. in. before the inner tube would be subjected to tensile strain.

The State Capitol, at Albany, N. Y., is to have $800,000 spent upon it under the bill just signed by Gov. Flower, and it is estimated that $2,250,000 more will be needed to complete it. Gov. Flower expresses the hope that it may be finished during his term of office, and so, probably, do the taxpayers.

The long distance telephone line, from New York to Chicago, is now being constructed, and is to be finished within the year. It is expected that the American Bell Telephone Co. will replace the 8,000 telephones in Chicago with copper metallic circuit instruments. The line is direct, without reference to railway routes, and its western terminus is now at Cleveland, O. Another transcontinental line, passing to Chicago through Pittsburg by a different route, is projected.

Surveys for the South Chicago Rapid Transit Railway have recently been completed, and construction work will be commenced at once. It is to extend from Jackson Park to South Chicago, a distance of 12 miles, and will have connection with the World's Fair Grounds. In the 12 miles the road crosses at grade 45 steam railway tracks, which does not indicate much of a step forward toward the abolition of grade crossings, of which Chicago has so many. Steam motors will furnish the motive power, and investigations are being made of the different makers' devices. A 75-lb. Horton girder rail is to be used, with six-bolt splice bars. The road is being built by the South Chicago City Ry. Co., Chicago, Ill. Mr. R. D. Rowe, M. Am. Soc. C. E., is the engineer in charge of construction.

The Chicago Power Supply & Smoke Abating Co. has been granted an ordinance permitting it to lay pipes in the streets for the transmission of compressed air for motive power.

The trolley system for Philadelphia proposed by the Traction Company of that city and for which that company is now asking authority from Councils, would cover Philadelphia with a perfect network of poles and wires, not only on outlying streets, but thickest in the heart of the city. The ordinance as framed gives an absolute grant of the streets to the Traction Company for this use, without compensation, consideration or restrictions. The company can use wooden or iron poles, place them in the middle of the street or on the curb-line, and does not promise any decrease in fares, though they admit that the running expenses will be decreased. In fact, the Traction Company, now one of the most powerful corporations in the city, will derive all the benefits and leave to the city only the empty privilege of granting the franchise. The whole affair has a queer look at a time when other large cities are vigorously fighting the trolley system, and it is little wonder that leading citizens and property owners find fault with the past and expected action of the men chosen to protect their rights against a merciless corporation little troubled by conscience.

The most serious railway accident of the week was a head collision March 6 near Rockville, Md., on the Metropolitan branch of the Baltimore & Ohio R. R. At Rockville the single track from Kensington runs into the double track to the west, and an eastbound freight train had been ordered to take the south track to let the Chicago limited pass. While pulling on to this track the injector check valve burst, blinding the engine driver for a moment with steam, and in that time the engine ran on to the single track, right in front of the express. The fireman and one brakeman of the freight train were killed, being crushed and burned under the engine.—Another serious accident was a derailment March 3 on the Baltimore & Lehigh R. R., near Baltimore, Md. The train consisted of an engine and tender, baggage car, smoking car and one passenger car. The baggage car jumped the track, and with the engine, tender and smoking car, went down the bank forming the approach to the trestle across Little Gunpowder Falls, while the rear car was overturned on the track. One man was killed and 3 were injured.

An explosion of car heating apparatus occurred March 6 in the car of an Atchison, Topeka & Santa Fe R. R. train near Meriden, Kan. There were 2 men killed and 5 injured. Press dispatches give no details of the accident.

The twin East River bridge bill, with its 3-mile elevated railway addendum, has been amended by the Assembly and the Senate, and is now approved by Gov. Flower's Two sections have been added to the bill, in substance as follows: The bridge structure is exempt from taxation, and the bridge corporation is exempt from taxes for 10 years after the bridge is opened to travel, provided that when the average gross earnings of either bridge shall for six consecutive months exceed $3,000 per day, the corporation shall be subject to taxation as provided by law, such tax to be assessed from the first day of such period. The corporation must furnish before Nov. 1 of each year, a detailed account of its daily and gross earnings to the chief fiscal officers of New York and Brooklyn. When the gross earnings for six consecutive months exceed $4,000 per day, the corporation must pay a sum equal to 1% on its gross earnings into the sinking funds of the two cities. An additional 1% is to be paid for each multiple of $4,000 per day. These payments are in addition to regular taxation as above provided. The elevated railway extension of the bridge must pay taxes as now provided by law.

The Chicago Drainage Commission has adopted the route recommended by Chief Engineer Williams on Feb 17, and it is promised that ground will be broken by May 1. This route, or No. 3 in the list of five considered in the report, is a new location throughout and lies as far as possible on the south and east side of the Desplaines River, but crossing some of its bends. The chief merits claimed for this route are that it can be excavated more nearly "in the dry" and is the cheapest route of the five discussed. A minority report of the Engineering Committee objected to the route on the following grounds: That the expenditure is beyond the resources of the District and includes work for which Federal co-operation should be secured. The development of water-power suggested should follow and not precede the drainage work, and it is doubted whether this will ever make a considerable return in view of the cheap coal at hand. If the District has funds to spare they would be better invested in making a deep channel for lake vessels at the Chicago end and in improving the harbor entrance. This minority committee objected to all routes with the Desplaines River as tributary to the main outlet. The majority report was adopted and the engineer and attorney were instructed to carry out forthwith the recommendations set forth in Mr. Williams' report. This means a legal location of the route and a condemnation of the necessary land.

The streets of Chicago are in a wretched condition, covered with mud, and the "Inter-Ocean" of that city properly says that the $450,000 appropriated is not enough to clean the 700 miles of paved and 1,600 miles of unpaved streets in Chicago. New York spends $1,700,000 on 3,000 miles of streets with better grades.

The new street-cleaning bill for New York City is now before the Legislature at Albany, as prepared under the direction of Prof. Chandler, Col. Greene, Mr. Jessup and the other members of the advisory commission. This bill divides the city into 11 districts, each under a district superintendent of street cleaning, and the same number of foremen, all held personally responsible for the condition of the streets. The force is to be uniformed, and is to consist of 2,250 sweepers and drivers, and 88 hostlers, at $600 per year each. A physical examination must precede appointment, but citizenship is not insisted upon. There would be a Chief Commissioner at $6,000 per year, removable for cause by the Mayor; a Deputy Chief at $4,000, general superintendent at $3,000, assistant superintendent at $2,500, and three time-collectors at $1,200 each. Clerks and other officers are also provided for. The aggregate force is fixed at 2,373 men, with power to increase at the rate of 5% annually. The street cleaning is to be done by hand, and each sweeper has a certain area to keep clean. The sweepers must furnish their own tools.

The use of pure nickel in the manufacture of liquid measures in France is made legal by a decree of Jan. 30, 1892. Within three months after the issuance of this decree no pewter measure will be accepted for official verification containing in their composition over 10% of lead or other metals ordinarily found in the pewter of commerce.

The London Main Drainage Committee, of the County Council, reports as follows on the operation of the sewage precipitation works at Barking and Crossness for the year ending Dec. 31, 1891: At Barking, 30,172 millions of gallons of sewage were treated with 8,518 tons of lime and 1,563 tons of sulphate of iron, producing 539,000 tons of sludge taken to sea. At Crossness, 2,228 millions of gallons were only partially treated with 407 tons of lime and 113 tons of sulphate of iron, making 46,872 tons of sludge. As a result of better working at Barking, the percentage quantity of sludge (corrected to 90% moisture) rose from 0.28% in 1890 to 0.36% in 1891. The theoretical quantity obtainable, on the assumption that 30 grs. per gallon are precipitated, is 0.43%.

TRIPLE-EXPANSION PUMPING ENGINES AT THE MILLBURN PUMPING STATION, BROOKLYN WATER-WORKS EXTENSION.

[With inset.]

In our issue of June 6, 1891, were illustrated and described the engine and boiler house at Millburn, L. I., for the Brooklyn Water-Works extension. The contract for the pumping engines and boilers for this station was awarded to M. T. Davidson, of Brooklyn, N. Y. The station will be equipped with four triple-expansion, direct-acting pumping engines, three having a capacity of 10,000,000 gallons per 24 hours and one of 4,000,000 gallons.

So far as we know, the only triple-expansion pumping engines in this country, aside from those built by Mr. Davidson, are five vertical direct-acting engines, of 15,000,000 gallons capacity each, built by the E. P. Allis Co., of Milwaukee, for the Chicago water-works. One of these engines was described and illustrated in our issue of May 31, 1890. They are vertical direct-acting engines, with valve-gear of the Reynolds-Corliss type, much heavier and more complicated machines than the Davidson engine, which is a simple horizontal direct-acting steam pump, with the three steam cylinders in line with the water cylinder. Fig. 1 is an elevation and plan of the Davidson engine. The intermediate cylinder is placed nearest the water cylinder and then come the low-pressure and the high-pressure cylinders. Steam is led by pipes from each cylinder to the next. The valves for the high-pressure and the low-pressure cylinders are plain slide valves, worked by direct connections with the main valve on the intermediate cylinder, which is similar in design to the valve used by Mr. Davidson on compound and and single-cylinder pumps.

The mechanism of this valve is illustrated in the accompanying drawing, Fig. 2. Its principal peculiarity consists in the fact that it is moved both by direct steam pressure and by mechanical connection with the main piston rod of the engine. The cylindrical steam chest (M) is bored out to make a face for the valve (A) and the pistons (B) and (B'), which assist in operating the valve. Sufficient space is allowed between the pistons for the valve and the steam ports. In the exhaust steam passage is placed a cylindrical cam, which is rocked back and forth by an arm connecting with a crosshead clamped to the piston rod. This cam engages with a steel pin in the center of the valve, and is of such shape that it moves the valve back and forth and also oscillates the valve on its axis. By oscillating the valve small passages are opened and closed, opening either end of the valve-case alternately to steam and to exhaust. This gives a quick opening of the ports, and largely relieves the valve motion of friction and wear.

When one of the main steam ports (f) is completely open, admitting steam to the cylinder and driving main piston, cam and valve in directions shown by arrows, the first movement of the cam will be to oscillate the valve preparatory to bringing it in proper position for the opening of the auxiliary steam port (e) to live steam, and (e') to exhaust. It will then bring the valve to its closure (mechanically) slightly before the end of the stroke of main piston, thereby causing slight cut-off and compression. It will then fully open the auxiliary port (e) to steam, and (e') to exhaust. The admission of steam to one end of the valve piston, the other being open to exhaust, throws the valve in the direction shown by the arrow, admitting and exhausting steam to and from the main cylinder for the return stroke.

The advantages of this arrangement are that the pump has no dead center, the auxiliary ports (e) and (e') being opened whenever the main steam ports (f) and (f') are closed. The closing of the valve before the piston reaches the end of the stroke eases the action of the pump and prevents the piston from striking the cylinder heads. The fact that the valve is moved mechanically as well as by steam also insures a uniform length of stroke.

In the engine illustrated, the valve cylinder, shown in Fig. 3, is 12 ins. in diameter, giving a large area for wear, and steam ports of ample size. The area of the valve piston is 113 sq. ins., so that the steam pressure furnishes ample force to work the valves of the three cylinders.

With a view to saving space, the intermediate and the low-pressure cylinders are set close together, the rear end of the first forming the head of the second. This made it impossible to use a central piston rod between these cylinders, there being no room for a stuffing box. The low-pressure piston, therefore, has two piston rods, which pass outside the intermediate cylinder but underneath its lagging, and are connected to a crosshead fastened to the main piston rod. The stuffing boxes for these rods are placed on the end of the intermediate cylinder farthest from the low pressure, and the rods work through brass bushings, thus making it as easy to care for these stuffing boxes as for those in the ordinary position. To facilitate starting the engine, a by-pass leads from the main steam pipe to the pipe connecting the high-pressure and intermediate cylinders, by which both these cylinders can be worked with live steam until the engine is under way.

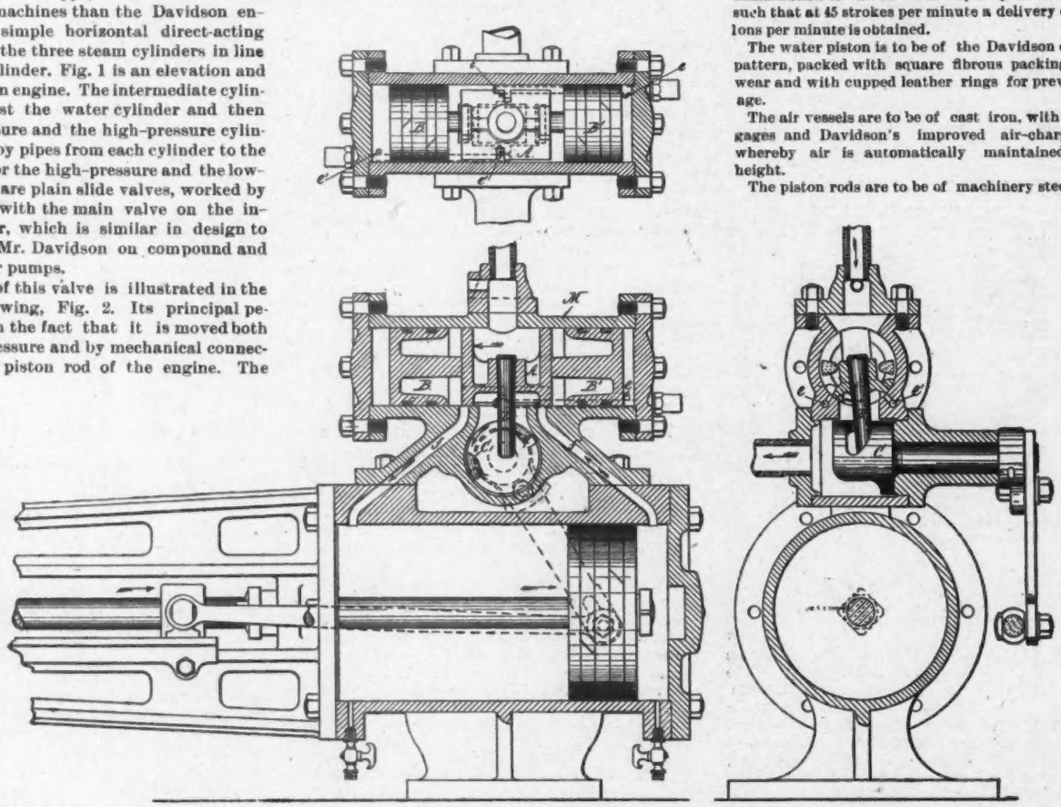


FIG. 2. VALVE MOTION OF DAVIDSON STEAM PUMP.

Fig. 4 shows the low-pressure cylinder and steam-chest. The steam ports are 1¼ by 14 ins. The high-pressure cylinder, shown in Fig. 5, has its left head cast in one piece with the right head of the low-pressure cylinder, and the pistons of the two cylinders are connected by a central piston rod. The steam ports for this cylinder are ⅛ by 5¼ in.

Fig. 6 shows the pump cylinder, which is so made as to give easy access to all valves by removing the bonnets. Fig. 7 is a section of the pump piston. Besides the flexible packing, the circumference of the piston is turned with grooves to diminish leakage when the packing is worn.

The type of boiler furnished with the plant is shown in Fig. 8. At present five boilers are to be set. Each boiler has 23 sq. ft. of grate surface and 807 sq. ft. of heating surface, a proportion of 1 to 35. The furnace heating surface is 169 sq. ft., and the tube heating surface is 638 sq. ft.

The specifications for the whole plant furnished by Mr. Davidson, we abstract as follows:

The steam cylinders are to be of 11½ ins., 20 ins and 36 ins. diameter, with a common stroke of 36 ins. They are to be made of hard cast-iron, and will be jacketed with live steam, the condensation being returned to the boiler by a small independent pump. Steam pistons are to be in one piece with packing rings sprung in, and re-enforced by brass springs pressing outward. The cylinders are to be covered with some approved non-conductor, then handsomely lagged with walnut strips, held in place by finished brass bands.

The water cylinder is to be of cast-iron, 36 ins. diameter by 36 ins. stroke, with removable lining of hard cast brass and brass valve seats, guards and springs. It is to be arranged for the suction connection on either side as convenient, and is to have ample openings for removal or examination of valves. The capacity of the cylinder is such that at 45 strokes per minute a delivery of 7,000 gallons per minute is obtained.

The water piston is to be of the Davidson combination pattern, packed with square fibrous packing for taking wear and with cupped leather rings for preventing leakage.

The air vessels are to be of cast iron, with brass water gages and Davidson's improved air-charging device whereby air is automatically maintained at proper height.

The piston rods are to be of machinery steel, secured to the pistons with brass nuts and jam nuts and to the crosshead by steel keys. The tie-rods for uniting the steam and water cylinders are to be of B. B. iron, neatly turned and finished.

An 8-in. brass revolution counter, with index graduated to six figures, is to be attached to each engine. Oil cups are to be placed at all points where lubrication is required, and a brass 1-qt. sight-feed lubricator is to be placed on the high-pressure steam cylinder.

With each engine is to be furnished a Davidson independent condenser with steam cylinder 8 ins. and air cylinder 14 ins. in diameter and a stroke of 16 ins. The air cylinder is to be lined with brass and will have brass valve seats and guards and sheet metal valves. Condensers are to have Davidson's vacuum breaking attachments to insure against flooding steam cylinder of main engines and possible damage to them by reason of inattention or negligence on the part of those in charge. Each air pump and condenser is to have a brass vacuum gage 8 ins. in diameter.

An 8-in. steam gage graduated to 100 lbs. is to be connected to the force main and placed in the engine room. Each water cylinder is to have a suction air vessel and a 30-in. suction pipe with flanges faced in a lathe.

The delivery pipe is to be 28 ins. in diameter, flanged and neatly fitted, and the three 28-in. pipes are to be connected to the 48-in. force main.

The steam connections from the boilers to all pumps

etc., are to be of wrought iron pipe, with the valves necessary to permit the operation of all or any one of the main engines, air pumps, etc. The steam pipes are to be covered either with magnesia covering, lagged with walnut strips and brass bands, or with some other non-conductor, handsomely painted and varnished.

The boilers are to have corrugated steel furnaces $\frac{7}{16}$-in. thick, with shells of $\frac{5}{16}$-in. steel having a tensile strength of 60,000 lbs. per sq. in., the longitudinal seams to be double riveted. The heads will be of steel $\frac{1}{2}$-ins. thick. Each boiler is to have its own damper in the uptake leading to the main flue. In the main flue at the most convenient point an automatic steam damper regulator is to be placed. Five boilers are to be furnished, any three of which will run the four pumping engines, with their air pumps, at the required speed. Each boiler is to have all necessary valves, cocks, gages, etc., and is to be so connected with the remainder of the plant that any one or more boilers can be shut off and the balance left running.

The boilers are to be set in cast iron saddles at least 16 ins. clear of the floor, so that the whole exterior can be got at for calking, repair, etc. They will be lagged with a non-conductor, outside of which will be canvas, painted and varnished.

Each boiler is to have an 8-in. steam gage graduated to 160 lbs. or more, a safety valve 4 ins. in diameter, and a 2 in. blow-off cock. Safety valves are all to be connected to one 8-in. pipe carried clear of the boiler house. Similar disposition is to be made of the blow-off cock discharge.

There are to be two boiler-feed pumps, arranged for hot or cold water and connected to boilers and to hot well. Each will have a 7-in. steam cylinder, 4-in. water cylinder and 10-in. stroke.

The 4,000,000-gallon engine is to have steam cylinders of 8 ins., 14 ins. and 24 ins. diameter, water cylinders of 24 ins. diameter, and 24-in. stroke. It will be in all respects, except dimensions, the same as the engines above described.

It is of interest to compare this pumping engine with other well known pumping engines. Of course, the first question which arises is as to comparative duty or fuel economy. In a power plant working under the conditions present in most water-works pumping stations, the matter of fuel economy is rightly considered of the first importance. A high-duty pumping engine, very expensive in first cost, may be much more economical in the long run than a cheap engine giving only moderate fuel economy.

So far no direct-acting steam pump (with the exception of the Worthington engine with the high-duty attachment) has been able to approach in fuel economy the fly-wheel engines, which store up the force exerted by the steam during the first part of the stroke and give it out again on the last part of the stroke when the steam is expanded and is pressing with less force upon the piston.

As to the question how the pump illustrated may be expected to compare in duty with the best types of compound duplex pumping engines, it is difficult to form any opinion without a comparison of indicator diagrams. The duplex compound can cut off the stroke and secure considerable expansion of steam in the first cylinder, and has the great advantage of securing a steady movement of the water at the pump end by the mutual action of the two cylinders.

The triple expansion engine here illustrated has the advantage of carrying on the expansion in three cylinders. If we assume that in this engine the valves of the three cylinders open and close in exact unison, and each valve remains open for the whole stroke, which we believe is practically correct, then the number of expansions obtained is the ratio between the areas of the high pressure and the low pressure pistons. Since these are to each other as the square of their diameters, or as $11\frac{1}{2}^2 : 36^2$, the number of expansions will be $1296 \div 132.25 = 10$ nearly. While the highest duties recorded by pumping engines have been obtained with greater ratios of expansion than the above, many excellent records have been made with about this number of expansions. The pumping engine at Lawrence, Mass., designed by E. D. Leavitt, expands the steam about 22 times, and the Pawtucket engine, designed by Geo. H. Corliss, expands the steam about 18 times. The ordinary duplex direct-acting engines have, as a rule, much smaller ratios of expansions.

The position of the high-pressure cylinder in this engine seems rather unfortunate for the attainment of a high duty, on account of the long pipe necessary to carry the steam to the intermediate cylinder. The clearance of the intermediate cylinder is practically increased by the volume of this pipe. This arrangement of the steam cylinders was adopted to permit the examination and packing or readjustment of each of the three steam pistons with the least delay and inconvenience.

The piston speed when working at the contract capacity is 135 ft. per minute. This again is much lower than that of the flywheel engines. The Lawrence engine works at about 216 ft. piston speed and the Pawtucket engine at about 250 ft. per minute. The speed of 135 ft. per minute, however, is certainly high for direct-acting pumps, and we understand that the engine is capable of as high speeds even as 200 ft. or 67 strokes per minute. It is remarkable that smooth motion and freedom from shock can be obtained from so large a pump moving its own valves.

It is to be hoped that a thorough duty test may be made of these engines after they are in place, that it may be known what economy can be attained with engines of this class. We believe Mr. Davidson is willing to guarantee a duty as high as 90,000,000 ft. lbs. per 100 lbs. of coal.

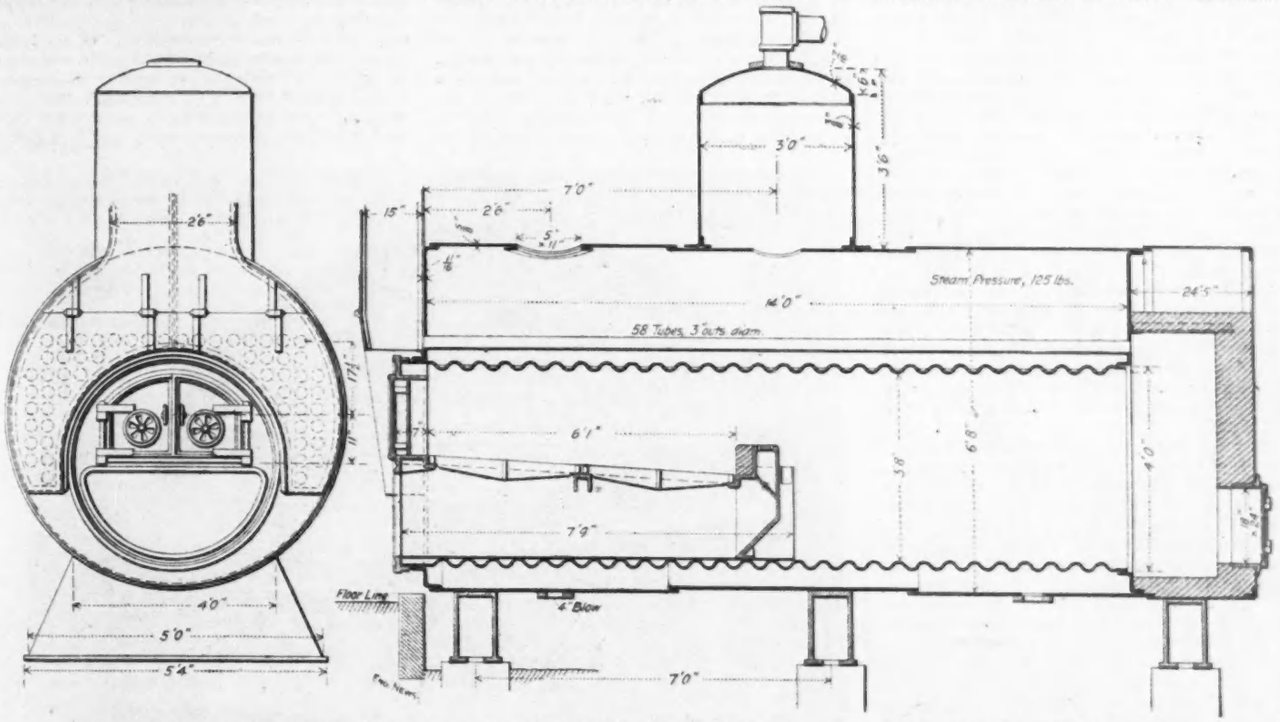


FIG. 8. RETURN TUBULAR BOILER WITH CORRUGATED FURNACE FOR MILLBURN PUMPING STATION, BROOKLYN WATER-WORKS.

ELECTRIC MINING MACHINERY AT THE VIRGINIUS MINES, OURAY, COLO.

A very interesting piece of work has recently been completed by the Edison General Electric Co. at the Virginius group of mines, near Ouray, Colo. These mines are situated near the summit of Mt. Sneffles, in the region of perpetual snow, at an altitude of 12,700 ft. above sea level and about 5,000 ft. above the timber line. The power station is situated nearly four miles from the mines, and the electric current transmitted over this distance is now driving machinery at the mine aggregating about 245 HP.

The difficulties and dangers encountered in establishing the plant were many. The mines are reached by a wagon road, open in the summer but impassable in the winter, when the only route to the mines is by a difficult trail, the lower part of which, denominated the "zig-zag," winds up a declivity so precipitous that burros with their packs slipping from the trail frequently roll down past several branches of the zig-zag before they are stopped by a tree or rock. The upper part extends over a rocky plateau above timber line, and along cliffs where the snow is frequently over 20 ft. deep on the level, and where terrific wind and lightning storms are frequent.

Naturally the expense of transporting fuel to the mines for operating machinery by steam power was almost prohibitory. Coal at the mines costs $18 per ton; and before the electric plant was installed, the cost of the power used at the mines amounted to about $40,000 per annum. This expense was so great that some of the mines in the group, producing a low grade ore, would have been shut down had it not been for the adoption of electric power. The managers of the Caroline Mining Co., the owners of the Virginius mines, had thus strong incentives to undertake the experiment of introducing electric power, even in the face of grave doubts regarding its success, which were entertained by some of the strongest advocates of electric power transmission.

The plant as installed derives its energy from the

waters of Red Canyon creek. The volume of water being small, considerable head was essential, and an iron pipe line was built along the side of the canyon for a distance of about 4,000 ft. At its head it takes water from the creek, a small dam being thrown across the stream, and at the power house at the lower end of the pipe line there is an effective head of 485 ft. The power station contains two Pelton water wheels, one of 500 HP. the other of 720 HP., connected to separate shafts so that either may be used independently of the other. The generating plant at present installed consists of one 100 K-W. and two 60 K-W. Edison dynamos, giving a total output of 293 electrical HP.

The wire circuit from the station to the mine is a little over 19,000 ft. in length, and operates under 800 volts E. M. F. Switches are so arranged that either the ground return or metallic circuit may be used, the metallic circuit being adopted at present. The construction and maintenance of this line presented one of the principal difficulties in connection with the installation. The lower half of the line from the power house to the foot of the zig-zag extends up a deep canyon through a forest of dense timber. The danger of breakage and grounds from falling trees, which are frequently blown down by storms and rest on the wires for some time before they can be removed, is continually present. The construction of heavy line work over nearly four miles of such ground was no small undertaking. Above the timber line the wires are strung over rocks and snow banks, where the poles and wires are likely to be carried away by snow slides, and where lightning storms are frequent and violent. These have caused indeed more trouble than anything else, but special forms of lightning arresters were eventually devised which give excellent protection.

The machinery at present operated at the mine consists of two pumps, one hoist, one blower and concentrators and stamps. Electric drills and locomotives will probably be added. The larger pump, which was erected when the plant was first installed, is a 60 HP. Knowles duplex. It forces 150 gallons of water per minute against a head of 700 ft. An Edison standard motor is geared to it by a double worm, one right hand and one left hand, working into two spur gears, which mesh into each other and operate the pump, the object of the two worms being to neutralize the longitudinal thrust. The smaller pump of 25 HP. is somewhat similar, the motor, however, being mounted over the pump with its armature vertical, the weight of the armature counteracting the thrust of the single worm used.

The use of worm gear to transmit such large amounts of power is a detail of the design which mechanical engineers will be apt to criticise. The counteracting of the longitudinal thrust without loss by friction, however, is most commendable.

The hoist consists of an Edison 25 HP. motor of standard type, but of street car winding and with a street car type of controlling switch, geared to the drum with a friction clutch connection.

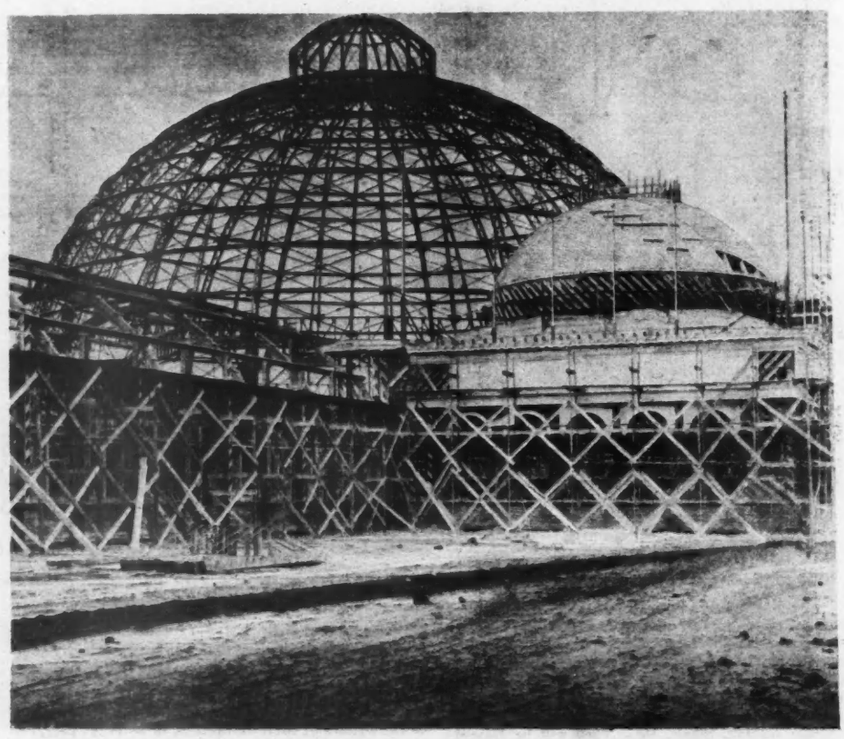
The concentrating and crushing machinery is driven by two 60 HP. Edison standard motors and the blower by a 15 HP. Edison motor.

Such an installation as that above described presents one of the most conspicuous examples of the advantages of electric transmission of power. The electric current flows as easily up a mountain side as along a level; and wherever the wires can be led, there the power is transmitted with ease and certainty. It is notable that this fact has been generally appreciated; and the most mountainous districts, such as Switzerland on the European continent and the Rocky Mountains in this country, are those where the greatest use of electric power transmission has been made.

WORLD'S COLUMBIAN EXPOSITION.

Dome of the Horticultural Building.

We give in this issue a view of the completed steel framing for the dome of the Horticultural Building, with a general diagram showing the dimensions and arrangement of members. Mr. W. L. B. Jenney, the architect of the building, designed the outlines and general dimensions of the dome, and the contract for construction was awarded to Binder & Seifert, of Chicago. The Bureau of Construction furnished the general design and strain sheet, and is responsible for the strains and sections in the structure, the strains being checked by the contractors, whose work included the making and working out of complete detail drawings to conform to the strain sheet and design, and furnishing and erecting the iron and steel work. The dome is 187 ft. 6 ins., diameter, 113 ft. 3 ins., high to top of main ribs, 135 ft. total height. The springing line is 22 ft. 6 ins. above the floor level, and the radius, outside of main ribs, is 93 ft. 9 ins. The dome consists of 20 main rafters, each rafter being made of four pieces. They rise directly from the top of the foundation, which is level with the ground, and run upward, curved toward the center, where they meet, and are riveted to two junction plates. These 20 rafters are connected with each other by means of girders, purlins, struts and rods. About 20 feet above the ground is a horizontal line of plate girders which not only serves as a strut, but also to carry a part of the gallery. About 14 ft. above this is a lattice girder, and above that at regular intervals are purlins, which are curved on the outside. All the material is of steel, conforming to the general specifications of the Bureau of Construction, and the work was turned out by the Schultz Bridge & Iron Co., in accordance with the detail drawings of Binder & Seifert. The contract for erection was sublet to F. J. McCain & Bro., of Chicago. The only false work used was a square framed wooden tower, 114 ft. high and 30 ft. square, which was built on its side, and hoisted into position by tackles attached to a gallows frame forming an extension of the base, and which frame lay on the ground when the tower was in position. Guys were attached to the top of the tower, and tension ropes ran from the end of the gallows frame to the top of the tower. To this tower were attached two booms, by which everything could be easily raised from the ground and hoisted to its proper place. First the 20 lower sections of the main rafters were erected and connected with each other by the plate girders. The other three sections of each rafter were riveted together on the ground, forming one piece of about 122 ft. in length, and this was hoisted up, one end being connected to the lower section already in place, and the other end resting on the tower. After all the material was delivered rapid progress was made, and the dome, with the exception of the lower sections and plate girders, which had been put in place beforehand, was finished in all its details in the course of four weeks. The entire erection was done in 30 actual working days. The total amount of material in the dome is 366 tons. A general view and description of the Horticultural Building were published in our issue of Feb. 13, and we shall probably give details of the construction later.



DOME OF HORTICULTURAL BUILDING, WORLD'S COLUMBIAN EXPOSITION.

Electric Lighting (Arc System).

Proposals for leasing electrical machinery and apparatus for the general illumination of the grounds and main buildings by arc lights will be received by the Bureau of Construction until March 15. This will include generators, station apparatus, switchboard, lamps, opal globes and globe nets. The total capacity required is about 5,000 lamps for interior illumination and about 1,000 lamps for the grounds. All arc light systems are eligible, and the lamps may be of any candle-power, but units of 2,000 c. p. each (nominal) are most desirable. Of the lamp capacity 10% is to be used for night lights, and must be capable of burning for at least 14 consecutive hours without having to be recarboned. The generators may be operated in series, but it is not considered desirable to operate any circuit at a difference in potential exceeding 3,000 volts. The circuits will be erected and maintained by the Exposition management, by whom also all power and connections, labor, attendance, oil and waste for driving the machinery will be supplied. One-third of the capacity is to be delivered by July 1, one-third by Aug. 1, and the remaining third by Sept. 1, 1892. The generators will be located in the space reserved for power plant along the south side of the Machinery Building. The location of the lamps will be decided later by the Grounds and Buildings Committee.

Electric Lighting (Incandescent System).

The following interesting particulars in relation to the lighting of the Exposition buildings are taken from the specifications issued by the Bureau of Construction for installing, operating, maintaining and removing electric lighting plant for the supply of incandescent lighting. Proposals based upon these specifications will be received until April 2 by Mr. D. H. Burnham, Chief of Construction. The lamps will be of 16 c. p., except those for decorative purposes around the Basin, which will be of 10 c. p. The number of lights to be provided for is given in the following list, in which Nos. 1 to 11 are for complete systems, including inside wiring; Nos. 12, 13 and 14 are for service connections without inside wiring; No. 15 is for a complete system requiring no

inside wiring, and No. 16 is for the system of mains and services only, without inside wiring.

	No of lamps.
1. Administration Building (also 8 arc lamps)	5,077
2. Agricultural Building and Annex	4,000
3. Fine Arts Building (9,434 of 16 c. p., 96 of 32 c. p.)	9,626
4. Fine Arts Annexes	6,616
5. Horticultural Building	800
6. Machinery Building and Annex	4,000
7. Manufactures and Liberal Arts Building	10,000
8. Mines and Mining Building	3,000
9. Music Hall and Casino	3,500
10. Transportation Building	2,500
11. Woman's Building	3,000
12. United States Government Building	5,000
13. Fisheries Building	500
14. Construction and Maintenance Building	1,500
15. Decorative lights around the Basin	7,080
16. States and foreign buildings, and the Midway Plaisance	26,500
Total number of incandescent lights	92,699

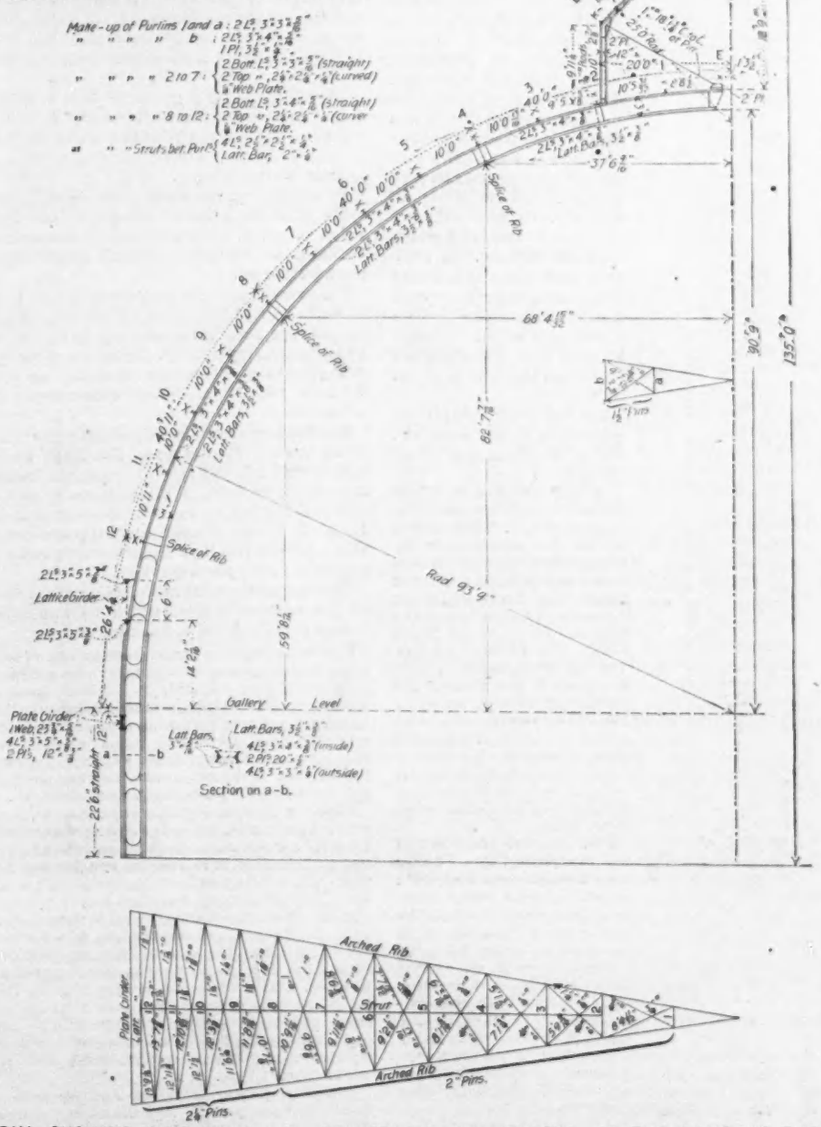


DIAGRAM SHOWING DIMENSIONS AND ARRANGEMENT OF MEMBERS OF THE DOME OF THE HORTICULTURAL BUILDING; WORLD'S COLUMBIAN EXPOSITION.

The generating plant may be located entirely in the space reserved for power plant in the Machinery Building, or may be supplemented with a central station located in the Midway Plaisance. The feeders and distributing mains may be run in the main subway described in Engineering News, Oct. 31, 1891, and on the elevated railway structure if desired, as far as practicable, and the remainder of the system is to be run underground in ducts, or by using a fixed system of conductors. The Exposition management will provide all supports for conductors in the subway, on elevated structure or in the dynamo room, ready for the pins and insulators, which must be provided by the contractor, and the contractor must also provide all labor and material connected with laying the system of ducts or fixed conductors, except excavation and refilling. The machinery and apparatus may be classified as an exhibit, and the plant is to be installed and operated under the "National Code" of rules adopted in August, 1891, by the National Electro-Insurance Bureau for wiring buildings for electric light or power.

The Exposition management will provide and maintain steam power and connections to same for driving dynamos, oil and waste, floors and foundations in dynamo room, underground ducts and subways, supports for conductors, lamp fixtures and shades. The contractor will provide and maintain generators and station apparatus, conductors and distributing appliances, including lamps and sockets. Generators to be connected direct to engine shaft must be furnished with engines complete. The generators are to be of sufficient combined capacity to operate the lamp capacity of the installation continuously and at normal E.M.F. for at least eight consecutive hours. Plants for the different buildings, etc., are to be in working order from January to November, 1893, from October, 1892, to February or December, 1894. The conductors are to be covered with a waterproof insulation, and in dynamo room and subways to be insulated from the supports by glass or porcelain insulators. If pressure lines are used to record at station the E. M. F. at center of distribution, they are to be made up in main cables, with the same grade of insulation as that for feeders. If an alternating current system is used, the primary wires must not enter the building, and the converters must be located in fireproof vaults provided by the contractor immediately outside the building. The wiring will include all the labor and material for a complete system of conductors from feeders to lamps, and the main conductors rising from the ground floor are to be readily accessible for inspection. Distributing or lamp circuits are to be run in interior conduits or moldings. The conductors are to be so proportioned, and the E. M. F. so regulated, that the variation in E. M. F., as measured at the lamp sockets, shall not exceed 2%, or in some cases 3%, under any conditions of load.

Water Pipe.

The Bureau of Construction has received proposals for an approximate length of 39,596 ft. of 4 in. to 36-in. cast iron water pipe, and a large amount of special castings for cast iron sewer pipe. The contractor is to commence delivery March 28 and complete it by May 7, 1892, the delivery being made free on board cars at Jackson Park, as ordered by the Engineer of Water Supply, Sewerage and Fire Protection. The pipes are to be of the usual kind, known as "socket and spigot," and in lengths of 12 ft. The sizes, quantities and weights are given below:

Inside diam.	Quant'y, net ft.	Depth of socket, ins.	Weight of 12-ft. length, Stand'd. lbs.	Max. lbs.	Min. lbs.
4-in.	3,215	4	290	296	275
6-in.	11,270	4	440	449	418
8-in.	11,885	4	600	612	570
10-in.	2,140	4	840	857	800
12-in.	3,950	4½	1,080	1,020	950
14-in.	680	4½	1,380	1,408	1,310
16-in.	700	4½	1,500	1,530	1,425
20-in.	520	5	2,380	2,428	2,260
24-in.	2,036	5	3,000	3,060	2,850
30-in.	2,600	5	4,100	4,185	3,895
36-in.	600	5	5,400	5,508	5,130

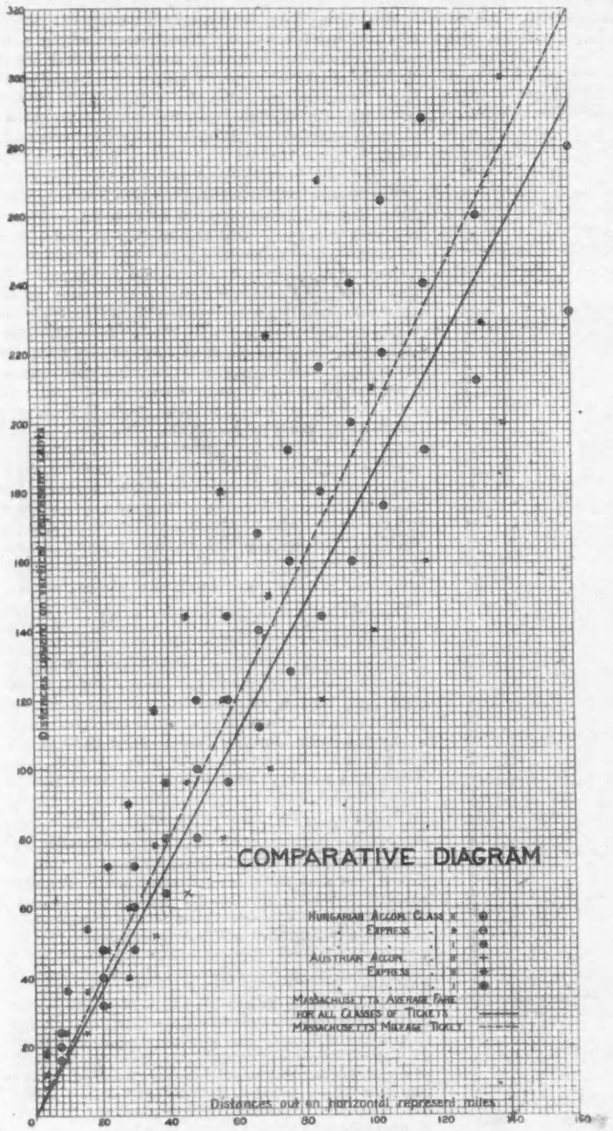
The following is an abstract of the specifications:

Each pipe shall have cast on the exterior surface of socket "C.C.W.W." in raised Roman letters 1½ ins. long, and shall be further marked in like manner with letters and figures to designate the maker of the pipe and the year, and with consecutive number. The pipe shall be cast vertically, without the use of core nails, chaplets, or thickness pieces or any substitute therefor. The metal shall be of the best quality for the purpose, made from "neutral" pig which shall have been made from iron ores, and without the admixture of cinder of any kind. When cast the metal shall be tough and of such density and texture as will admit of its being easily cut and drilled by hand. Chemical analyses shall be furnished by the contractor whenever required by the engineer. From each ladle of melted iron shall be cast, either before or after the pipe has been formed, test pieces 26 ins. long and 1 by 2 ins. section. These test bars shall support a center load of 1,900 lbs. with ¼ in. deflection before breaking, when set with narrow sides vertical on supports 24 ins. apart in the clear. The pipes shall be free inside and outside from scoria, sand holes, effects of air bubbles, cold shuts, laps, or other imperfections of castings; and shall be truly cylindrical, of full specified diameter, straight in their axis and of uniform thickness. The surfaces of pipes and sockets shall be smooth, and thoroughly cleansed of sand, lumps or rough places. All pipe shall be coated inside and outside with coal tar varnish, prepared and applied before any rust sets in. Each pipe shall be subjected to a test by hydrostatic pressure of not less than 250 lbs. per sq. in., and while under such pressure the pipe shall be subjected to an additional test of a series of smart blows at various points throughout its length, with a 3-lb. hammer, attached to a handle 16 ins. long. Pipes weighing over 5% less than specified standard weight shall be rejected, and no weight allowed or paid for in excess of 2% above the standard weight. Each pipe will be weighed at the foundry, and the weight plainly marked upon it.

Intramural Transportation.

Only two proposals have been received by the Bureau of Construction for the construction and operation of an elevated railway within the grounds, although proposals have been advertised for since January. A notice of the proposed line was given in our issue of Jan. 16. The Multiple Speed & Traction Co. made a proposition to put in the movable sidewalk system described in our issue of Feb. 27. The plant is to cost $750,000, and the company proposes to give the Exposition management 37% of the gross receipts after deducting therefrom the cost of plant and operation. It promises to transport 40,000 passengers an hour past a given point, furnishing each person a seat. The fare is to be 5 cts., which will permit the passenger to ride as

long as he chooses. The track is to be carried on a steel structure with a single line of columns; platforms and stairways to be provided at intervals of 400 ft. The King Bridge Co., of Cleveland, O., made a proposition to run a novel electric railway known as the unicycle railway. There would be 30 trains of two cars each, a motor and a trail car, carrying passengers per train, the round trip of five miles, including 24 stops, to be made in 30 minutes, the capacity being 9,600 passengers per hour. The fare to be 5 cts., of which ½ ct. per passenger would be paid to the Exposition management.



Comparative Diagram of Hungarian, Austrian and Massachusetts Railway Fares.

THE ZONE SYSTEM AND MASSACHUSETTS RAILWAY FARES.

One of the most valuable features of the Massachusetts Railway Commission report, issued this week and reviewed elsewhere, is a complete and thorough report, as called for by a resolution of the legislature, on the Hungarian and Austrian zone system and the expediency of adopting it in Massachusetts. The commission finds that no feature of the system appears to promise any advantage over present practice in Massachusetts. Every reader who feels an interest in the question will do well to get a copy of the report, for it is not likely that any more careful study of the question will appear for a long time. We reproduce with this issue the last of a series of nine diagrams which are included in the report, and which gives a kind of resumé of the whole comparison of rates, as also a part of the rate chart for the Boston & Albany road. We have already published very full descriptions of the Hungarian zone tariff (adopted Aug. 1, 1889,) and the Austrian (adopted June 16, 1890,) and therefore pass over the detailed description of them given in this report, though it is the best which we have seen.

After giving this description of the two zone systems the report notes that in Hungary, before the adoption of the zone system, 0.7 times the population made yearly a trip of 37½ miles; in Massachusetts 35 times the population made an average trip of less than 15 miles. In Austria twice the population made a mean trip of 23 miles. The difference of conditions in this respect only was therefore great. Moreover, Hungary had three different classes of passengers on each of three different classes of trains, or nine different classes of tickets in all, where we have only one. In addition, there were many round trip, season and other special kinds of tickets. In Austria it was even worse. A change of some kind was therefore demanded there, as it is not here.

The following records an interesting and curious fact, which we have not given heretofore:

The only kind of season tickets issued in Austria are called subscription tickets. These tickets are of two descriptions: (1), yearly tickets good on all lines upon which the tariff is in force; and (2) yearly tickets for limited distances. These tickets can be used for all scheduled trains except the Oriental express. They are not transferable. They are issued in the name of the holder and must be signed by him and his photograph must be affixed to the ticket. The table given below shows the rates.

The limited distance tickets are good only for the specified distance from the station named on the ticket.

These rates for yearly tickets are remarkably low. Under them it would be as cheap for a person to buy a yearly ticket, good throughout the year on 4,000 miles of railroad, as it would to travel in the corresponding class in an express train 3,800 miles, or in the corresponding class in an accommodation train 5,700 miles. So also, taking as an example the yearly ticket for 62 miles it would be as cheap to buy one of such tickets good for a year as it would to make 25 trips of the same length in an express train or 37 trips of the same length, in an accommodation train.

	Third class.	Second class.	First class.
Good on all lines or a little over 4,000 miles of railway	$40.00	$80.00	$120.00
Good for 31 miles	18.40	27.60	36.80
" 62 miles	24.90	36.80	49.20
" 124 miles	36.80	55.20	73.60

There cannot be many "steady travelers" in Austria or the above rates for tickets, good for a year for any amount of travel on any part of 4,000 miles of road, would lead to heavy loss of revenue.

Passenger traffic to and from Boston is 28% of the whole passenger business of the state. The population of Boston, we may note, is almost exactly 20% of the state's population, and if we allow for that considerable amount of travel which nominally terminates in Boston, but is really only in transit through Boston to its suburbs and adjacent towns, the amount of travel per inhabitant would appear to be no greater in Boston than in other parts of the state.

The following table, computed from a table given in the "Archiv fur Eisenbahnwesen" for 1891, gives a general idea of the relations which the rates of fare in different countries bear to each other, and is worthy of reproduction:

By comparing the rates given in the foregoing table with the average Hungarian and Austrian rates, shown on the accompanying diagram, it will be found that the Hungarian and Austrian rates are the lowest of all.

The average receipts per passenger mile in Massachusetts are 1.83 cts.; in the United States, 2.17 cts. The average transient rates may be said to be 2 1-2 and 2 3 4 cts. respectively. In Hungary the average first-class rate for less than 140 miles may be called 2 1-2 cts., with 1-2 to 1-6 ct. per mile extra for 150 lbs. of baggage.

The diagrams above noted, which show for each of the leading Boston roads the rates for single trips, round trip and monthly commutation tickets, are very interesting. We reproduce a part of one of them showing the rates for the Boston & Albany R. R. The lines showing single trip and commutation rates (for less than 100 trips) continue on indefinitely in nearly a straight line.

The comparative diagram of Hungarian, Austrian and Massachusetts rates which we also reproduce is thus explained and commented on:

In order to facilitate a general comparison of the Austrian, Hungarian and Massachusetts rates a comparative diagram has been prepared. It is evident that if traffic were evenly distributed, the same receipts would be obtained from a zone system as from a mileage system, when the lines representing the mileage system cross each horizontal line representing the zone system at its middle point. In the comparative diagram, therefore, the fare for the middle point in each zone is indicated.

Under the Austrian and Hungarian systems, the towns within a given zone, nearer to the point of departure than the middle of said zone, would pay more than they would under a mileage tariff represented by a line crossing said zone at its middle point, and the towns on the further side of said middle point would pay less.

In examining the diagram it must be remembered that under the Hungarian system the fare does not increase beyond 140 miles. The indicators for such system on the 160 mile line therefore show the fare for all distances over 140 miles. As the best means of comparing the Hungarian and Austrian rates with Massachusetts rates, a line is plotted showing the 2 ct. per mile mileage ticket rate, and also a line showing the average fare per mile for all classes of tickets on roads reporting to the Board. This average rate of fare is 1.83 cts. per mile.

Both under the Hungarian and Austrian systems, the fare for first-class passage on accommodation trains is,

	Single fare, cents per mile— I. class.	II. class.	III. class.	IV. class.	Excess baggage per 100 lbs.	Free baggage.
England (all trains)	4.23	3.00	2.11	....	1–30 m. $0.51 30–50 m. 1.02 50–150 m. 2.04 150–300 m. 3.06 over 300 m., 4.08	I. 130 lbs. II. 110 lbs. free. III 66 lbs. 66 lbs.
France* (exp. and accom)	3.78	2.84	2.08	....	0.77 cts. per mile.	
Belgium (State r'ys., accom.)	2.32	1.74	1.16	....		
Express	2 9	2.18	1.45	....	.....	None.
Netherlands (State r'ys., all trains):						
Up to 31 miles	3.26	2.61	1.63	....		
31 to 62 miles	2.51	2.09	1.30	....	0.42 cts. per mile plus 16 cts. for checking.	
62 to 93 miles	2.28	1.83	1.14	....		
93 to 124 miles	2.02	1.70	1.06	....		
Over 124 miles	1.95	1.57	0.98	....		
Prussian (State r'ys., accom.)	3.07	2.30	1.54	0.77	.....	55 lbs.
Express	3.46	2.56	1.75	....		
Sweden (State r'ys., accom.)	3.01	2.26	1.51	....	0.38 cts. per mile.	
Express	3.66	2.58	1.72	....	.....	55 lbs.
Russia (accom.)	2.58	1.94	1.08	....	2.88 cts. per mile.	35 lbs.
Italy (accom.)	3.47	2.43	1.56	....		
Express	3.82	2.68	1.73	....	.....	None.

*In France there is practically a sharp distinction between the rates by express and by accommodation trains, but it is effected by running only first and second class cars on the faster trains.—Ed.

with few unimportant exceptions, the same as the fare for second-class passage on express trains.

It will be seen that the Austrian second-class accommodation train fares are lower than the Hungarian second-class accomodation train fares; that the first-class Austrian accommodation train fare and its equivalent, the second class express train fare are very nearly the same as the corresponding fares on the Hungarian railroads; while the first class Austrian express train fare is higher than the first-class Hungarian express train fare. The variation in fares between the different classes on the Austrian railroads is greater than the variation in fares on the Hungarian railroads. The Austrian railroads have the highest and the lowest fares. No figures are yet obtainable showing the average rate of fare for all classes of tickets on the Austrian and Hungarian roads.

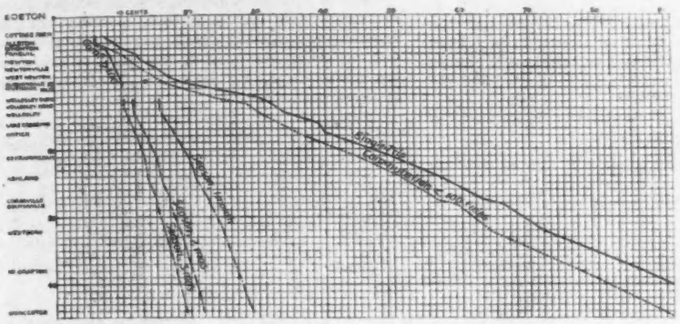


Diagram Showing Fares by Different Classes of Tickets for all Stations Between Boston and Worcester; Boston & Albany R. R.

In comparing the Austrian and Hungarian rates with those in Massachusetts, various considerations should not be lost sight of:

1. As a rule the Massachusetts roads give better and more frequent service than the Hungarian roads.

2. The average rate of speed of trains in Massachusetts is higher than the average rate of speed in Hungary. The five main lines running into Boston report their average rate of speed as follows:

	Miles per hour.
Accommodation trains within suburban limits	22
Accommodation trains beyond suburban limits	29
Express trains	37

Hungarian maximum speeds are 25 to 28 miles per hour.

3. Both in Austria and in Hungary a passenger having any baggage other than that which he can carry in his hand is obliged to pay extra therefor. It appears that the receipts for transportation of baggage in Hungary in the year 1889-90 were equal to 5% of the total passenger receipts.

4. The wages of labor in Austria-Hungary are about one-third, certainly less than one-half, of those paid in Massachusetts.

The following table shows the average wages per annum paid certain classes of employees, in the United States, in the New England states, in Great Britain, in Prussia and in Hungary. The wages paid in the United States, the New England States and in Great Britain are taken from the report of the Commissioner of Labor, 1889, pp. 144-145. The wages paid in Prussia are taken from the supplement to the budget of the Prussan railways, 1886-7. The average wages paid in Hungary are computed from the subjoined table, made up from official sources and forwarded to the Board by Prof. A. Goering of the Polytechnic Institute at Berlin.

Occupation.	U. S.	New Eng.	G't Br't'n.	Prussia.	Hungary.
Baggage-masters	$510	$557	.....	$288	.....
Conductors	844	883	$304	285	$324
Engineers	1,069	1,041	457	360	324
Firemen	502	502	285	252	.....
Flagmen	354	390	254	169	.....
Section foremen	589	731	.....	522	230
Switchmen	471	557	285	243	172
Telegraph operators	449	446	.....	306	265

5. The hours of labor in Austria and Hungary are more severe than the hours of labor in Massachusetts. The normal working day is as follows:

Office employees 8½ hours; workshop workmen, 10 hours; station employees and trainmen, no regular length of day; the maximum must not exceed 24 hours at a time, preceded and followed by a rest of at least 12 hours. The regulation of the hours of rest is established by the following general rules:

1. On lines where there is not much traffic (6 to 8 trains a day) the plan adopted, to prevent their being no time available for repose between the trains, is to allow at least 6 hours rest in every 24 hours.

2. On lines where there is more traffic, the servants employed in permanent way and train service are granted 6 hours' rest after every 12 hours' work.

3. The employees at stations where there is not much work beyond the train service have 12 hours' rest after every 24 hours' work. In larger stations, however, they are granted 24 hours' rest after every 24 hours' work.

SCREW AND SIDE WHEEL STEAMERS FOR LONG ISLAND SOUND.

Two screw steamers for the Stonington Line, to run from New York to Stonington, R. I., in connection with trains to Boston, Mass., are being built by Harlan & Hollingsworth, at Wilmington, Del., and will be the first of their kind on any of the Sound lines. They have iron hulls, and each boat has a single screw propeller instead of the usual side wheels. They will be named the "Maine" and "New Hampshire." The former is practically completed and has been given a trial trip. These steamers are 310 ft. long over all, 302 ft. 7 ins. long on the water line, 44 ft. beam on the water line, 60 ft. wide over the guards, and have a draft of 12 ft. 6 ins. aft. Their displacement, loaded, is 2,550 tons, and gross tonnage, 2,397 tons. The propeller is of cast iron, left handed, with four blades, and is 13 ft. 6 ins. diameter. It is driven by an inverted, vertical, direct acting, triple expansion engine, with surface condensers. The engine has a high pressure cylinder 28 ins. diameter, intermediate cylinder 45 ins., and two low pressure cylinders 51 ins. diameter, all with a stroke of 42 ins. The engine is estimated at 3,000 HP. There are four Scotch or marine boilers, 13 ft. 6 ins. diameter and 11 ft. 6 ins. long, with three corrugated furnaces 46 ins. outside diameter, giving each boiler a grate area of 274 sq. ft. The boilers are of steel, having a tensile strength of 60,000 lbs. per sq. in., and will carry a working pressure of 160 lbs. per sq. in. The Williamson combined steam and hand steering gear is used. Blowers with a capacity of 20,000 cu. ft. of air will be put in, and the firerooms will be arranged for forced draft on the closed fireroom system, in case it is decided to adopt this system.

The hulls are built of steel, have single bottoms, and are divided into seven water-tight compartments. A single acting air pump is worked by levers from the main engine, and there is a centrifugal circulating pump. Two bilge pumps are worked from the air pump crosshead, and there is an independent feed pump and a steam donkey pump. The staterooms are heated by steam pipes and the saloons by radiators, the steam-heating service being connected with the main and donkey boilers. The boats will be lighted throughout by electricity and will have electric side and stern lights, and an electric search light in front of the pilot house. They will carry each 500 passengers, a crew of 70 men and 600 tons of freight. The main saloon is 243 ft. long and the interior arrangements are very elaborate. The dining room is on the main deck. The staterooms and officers' quarters have a very complete electric call service. The "Maine" was launched last autumn and the "New Hampshire" in January, 1892. On the recent trial trip of the former she showed an average speed for eight hours of 17.6 knots, the guaranteed contract speed being 17 knots. Both steamers are to go in service next May for the summer season. Mr. J. W. Miller is President of the Providence & Stonington Steamship Co., which runs the Stonington Line, and Mr. Samuel J. Clarke is the company's Superintendent and Engineer.

The distance from New York to Stonington is 124 statute miles, and the length of time of the trip is estimated at 7.3 hours, the maximum speed of the steamers being estimated at 17 knots, or miles per hour. The coal consumption per trip is estimated at 20 tons, including the coal consumed by electric machinery, sanitary pumps, etc.

The present side wheel steamers of the Stonington Line are 262 ft. long over all, 40 ft. molded beam, 60 ft. wide over the guards, and have a tonnage of 1,634 tons. They have the ordinary type of vertical engine, with walking beam and jet condensers, and vertical cylinders 6 by 12 ft. Their coal consumption is about 22 tons per trip.

As noted in our issue of Jan. 23, the engines of the steamers running on the waters around New York, including the Hudson River and Long Island Sound steamers, with their trips of 120 to 150 miles, are generally of the familiar vertical type, with overhead walking beam and side wheels. The modern engines of this type are a development of a very old class of steamboat engines, beginning as non-condensing engines. The latest and largest steamer fitted with this type of engine is the well-known "Puritan," of the Fall River Line between New York and Fall River, R. I., connecting with trains to Boston, Mass. She is 420 feet long over all, 404 ft. long on the water line, 52 ft. beam of hull, 91 ft. wide over the guards, 21 ft. 4 ins. depth of hold amidships and 70 ft. from base line to top of house over the engine. Gross tonnage, 4,650 tons; total displacement when loaded, 4,150 tons. She has a double hull, built of steel, the space between being divided into 52 water-tight compartments, while the interior of the hull is divided by seven transverse water-tight bulkheads. The decks are of steel plating covered with wood, and the masts are of steel, made to serve as ventilators. The side wheels are of steel, 35 ft. diameter over the floats, which are of ⅜-in. steel, 14 ft. long and 5 ft. wide. The total weight of each wheel is 100 tons and they make 24 revolutions per minute. They are of the feathering type. The engine is a compound, vertical, surface condensing beam engine of 7,500 HP. The high pressure cylinder is 75 ins. diameter and 9 ft. stroke, and the low pressure 101 ins. diameter and 14 ft. stroke. The cylinders are at one end of the beam, while at the other end is the connecting rod to the single crank, the crankpin of which is 19 ins. diameter and 22 ins. long. The walking beam is said to be the largest ever built. It is of diamond shape, 34 ft. long, c. to c. of ends, 17 ft. deep at the middle and weighs 72 tons. Its main bearings are 19 ins. diameter. The gallows frame carrying the beam is of steel angles and plates. The shafts have main bearings 27 ins. diameter, and gunwale bearings 30 ins. diameter. Steam is supplied by eight return tubular boilers, built of steel, giving a heating surface of 26,000 sq. ft. and a grate area of 850 sq. ft. The boiler pressure is 110 lbs. per sq. in. The coal consumption is about 120 tons during the round trip.

It is probable that a considerable economy in fuel consumption will be effected in steamers of this kind by the introduction of triple expansion engines and higher boiler pressures, as in the case of the new boats above described, in which, as already noted, the estimated coal consumption is two tons per trip less than for the older and smaller steamers.

ERRATA IN BAKER'S "MASONRY CONSTRUCTION."

The following is a list of errors found in Baker's "Masonry Construction" since the list published in Engineering News of March 22, 1890, p. 274:

Page
46, 3d line from bottom, for 26 read 23.
101, 2d " " " 37 " 17.
" " " " "XVII." XV.
170, eq. (4) " 15 " 18.
171, in the formula, " 15 " 18.
" " " " 75 " 90.
" line below, " 75 " 90.
179, 13th line from bottom, for above read below.
" 12th " " after care insert not.
277, 16th " " for 154 read 254.
" 18th " " " 210 " 260.
311, 3d line, for "at the end of the chapter" read in § 520, p. 334.
319, 3d line of § 497, for greater read less.
322, eq. (17) " w read W.
" 3d line of § 503, " AL" AK.
331, foot note, " XX. read XIX.
383, " channel read shore.
434, last line, " 424 read 426.
443, 8th line, for "the middle of" read "some point a in."
" next to last line, for R_2 read R_1.
" last line, " R_2 " R_1.
474, Fig. 129, the line $V a b$ should run to V.
478, 5th line, after center of insert moment for.

487, eq. (25) for $\sqrt{\frac{1-\sin\varphi}{1+\sin\varphi}}=\sqrt{\frac{1}{3}}$ read $\sqrt{\frac{1+\sin\varphi}{1-\sin\varphi}}=\sqrt{3}$

500, 6th line from bottom, for 47 read 27.
" " " " " 449 " 496.

The Manchester Ship Canal Co., Manchester, England, will receive proposals until March 24 for the completion of the works, including the portion from Runcorn to Randle's Creek, about 2½ miles. The contract will comprise about 1,500,000 cu. yds. of excavation, the protection of slopes, construction of roads, drain outfalls, etc.

JOHNSTONE'S DOUBLE TRUCK COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

In our issue of Aug. 29, 1891, we illustrated and described a ten-wheel compound locomotive designed by Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery, Mexican Central Ry., and six engines of this kind had then just been built for that railway by the Rhode Island Locomotive Works, Providence, R. I. The compounding is on the four-cylinder system, but with the novel arrangement of placing each high pressure cylinder inside the corresponding low pressure cylinder, the steam space of the latter being therefore an annular chamber.

These engines have given very satisfactory results in service, and Mr. Johnstone has now prepared plans for applying this four-cylinder compound system to a double truck engine, the general design of which is shown by the accompanying side and end elevations, and full details and drawings of which we shall publish in a later issue. Contracts will shortly be placed for the construction of some of these engines. This type of engine is somewhat similar in general arrangement to the double boiler, double truck, Fairlie type of engine, and was designed and patented as a simple engine by Mr. Johnstone in 1885 as an improvement on the Fairlie type. One of the radical differences is that while in the Fairlie engines the cylinders of each truck are carried on the truck frames, in the Johnstone engines they will be carried on the main frames, a special design of motion being used to transmit the power to the driving wheels. The engine has two boilers carried on a long, rigid frame. The fireboxes are set back to back, and have fire doors in the sides, and as they are situated between the trucks they can be made the full width between the main frames. The outer end of each boiler has an extension smokebox and a plain smokestack of the pattern which is now becoming very general. The cab is at the middle of the engine. The water supply is carried in saddle tanks.

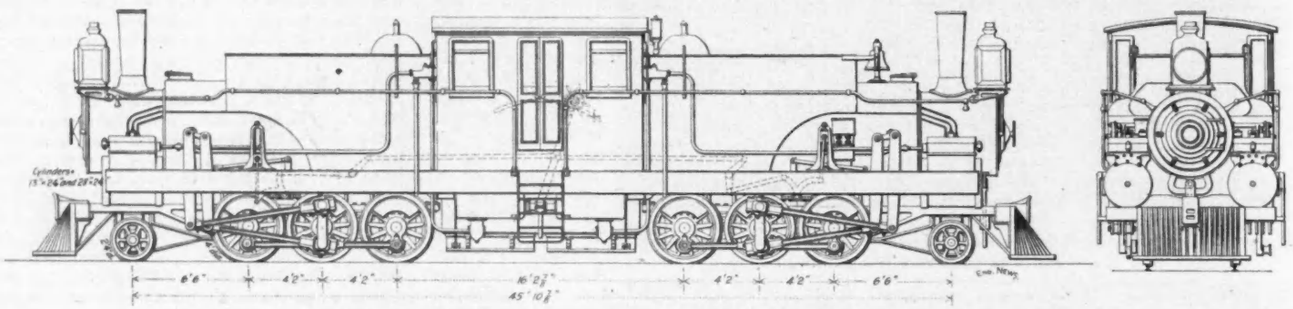
The main frame, carrying the boilers and cylinders, is supported on two six-wheel driving trucks in front of each of which is a two-wheel or pony truck, the radius bar of the pony truck being pivoted to the front of the frame of the driving truck, while the pilot, or cowcatcher, is also attached to an extension of the main truck frame. In regard to the transmission of power from the rigidly attached cylinders and cross-heads to the swiveling driving trucks, Mr. Johnstone's patent specifications (1885) include "mechanism for transmitting power from the pistons to the driving wheels, whereby the free movement of the trucks is permitted without affecting the normal action of the pistons upon the crank pins; mechanism for effecting the rotation of the driving wheels through crank arms of greater length than half the stroke of the pistons; and mechanism for controlling and maintaining the movement of the steam distribution valves in proper relation to that of other reciprocating parts under all conditions of traverse of the trucks." These specifications also provided "a system of lever connections between the cross-heads and connecting rods, whereby the piston speed is reduced relatively to a given speed of engine." These arrangements we shall describe more fully when we publish the detail drawings. In the meantime we give Mr. Johnstone's general claims for his type of driving gear as follows:

Inasmuch as the weight which can be carried upon each driving wheel of a locomotive cannot, without involving undue wear and strain upon the roadbed and superstructure and upon the tires, be materially increased above that obtaining in the usual practice, increase of tractive force can be properly attained only by an increase in the number of driving wheels, a limit to which is imposed, under ordinary constructions, by the necessity of adapting the engines to traverse curved portions of the lines. Increase of tractive force, together with capacity of passing short curves, has been heretofore sought for in engines of the so-called Fairlie type, in which the driving wheels have been grouped in one or more swiveling trucks, which likewise carry the cylinders. Such construction involves the objection, which practice has indicated to be a material one, of necessitating unduly long steam and exhaust pipes and flexible joints therein, which are expensive and difficult to make and maintain.

Under my invention the engine and tender [or practically two engines as in the case illustrated.—Ed.] are mounted on a single rigid frame, to which the cylinders are likewise secured, while the driving wheels are mounted in one or more swiveling trucks, thereby obviating the objection above stated, while retaining the advantage of the Fairlie construction as to facility of curving.

The leading dimensions and particulars of the engine illustrated are as follows:

Gage of track	4 ft. 8½ ins.
Fuel	Soft coal.
Cylinders, h. p.	13 × 24 ins.
" l. p.	28 × 24 ins.
Diameter of driving wheels	4 ft. 9 ins.
" truck wheels	2 ft. 4 ins.
" boilers (inside)	4 ft. 4 ins.
Form of firebox	Belpaire.
Size of firebox (at grate)	4 ft. 8 ins. × 4 ft. 8 ins.
Tubes, number in each boiler	201
" diameter outside, 2 ins.; pitch	2¼ ins.
" length	15 ft. 9⅛ ins.
Driving wheel base (each truck)	8 ft. 4 ins.
Total "	45 ft. 10⅞ ins.
Weight on driving wheels	200,000 lbs.
" total, in working order	230,000 "
Capacity of tanks, total	3,000 galls.
" bunkers	5 tons.
Brake fittings	New York train and driver air brakes.



JOHNSTONE'S DOUBLE BOILER, DOUBLE TRUCK COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

UNITS FOR THE MEASUREMENT OF WATER FOR IRRIGATION—CORRECTION.

Our attention has been called to some slight errors in the table which appeared on page 209 of our issue of Feb. 27, 1892, under the above heading. The table was taken from "Irrigation Statistics of Utah," and was originally prepared in great haste for the Salt Lake City Irrigation Congress held last fall. We corrected some typographical errors in the table before reprinting it, but failed to notice errors due to changing from months of 30 days to longer periods where the extra day in months with 31 days were ignored. The corrected table is as follows:

1 cu. ft. per second equals:

2 acre feet in 24 hours.	7.5 gallons per second.
60 acre feet in 30 days.	449 gallons per minute.
180 acre feet in 90 days.	50 California inches.
730 acre feet in 1 year.	38.4 Colorado inches.

100 California inches equals:

4 acre feet in 24 hours.	15 gallons per second.
1 acre foot in 6 hours.	900 gallons per minute.
120 acre feet in 30 days.	77 Colorado inches.
360 acre feet in 90 days.	2 cu. ft. per second.
1,460 acre feet in 1 year.	

100 Colorado inches equals:

5⅓ acre feet in 24 hours.	19.5 gallons per second.
1 acre foot in 4.2 hours.	1,170 gallons per minute.
155 acre feet in 30 days.	2.6 cu. ft. per second.
465 acre feet in 90 days.	130 California inches.
1,186 acre feet in 1 year.	

MINERAL PRODUCTS OF THE UNITED STATES.

Census Bulletin No. 166 gives a complete exhibit of the quantity produced and value of all the mineral products of the United States for the years 1880 to 1889, inclusive. The bulletin was prepared under the direction of Dr. David T. Day, special agent. The 55 varieties of minerals named in the tables are grouped as metallic and non-metallic. The total value of the production for the years 1889 and 1880, the increase for the period shown, and the percentage of increase are as follows:

Products.	1889.	1880.	Increase.	In p.c.
Metallic	$269,590,487	$190,039,865	$ 79,550,622	41.86
Non-metallic	307,640,175	173,279,135	134,361,040	77.54
Unspecified	10,000,000	6,000,000	4,000,000	66.67
Total	$587,230,662	$369,319,000	$217,911,662	59.00

The coal marketed in each year in long tons and the mean price per ton (which latter we compute from the value given) were as follows, the total output, including that used at the mines or otherwise not marketed, being given for 1880 and 1889 only, and given in parentheses.

Coal Marketed.

Years.	Bituminous. Quantity.	Bituminous. Price.	Anthracite. Quantity.	Anthracite. Price.
1880	(38,242,641)	....	(25,580,189)	....
1882	57,963,008	$1.25	29,120,496	$2.25
1883	65,460,171	1.20	31,793,027	2.25
1884	66,809,326	1.05	30,718,293	2.00
1885	63,569,284	1.27	32,265,421	2.24
1886	63,380,119	1.19	32,764,710	2 18
1887	75,454,464	1.26	35,273,442	2.25
1888	87,602,534	1.12	39,216,872	1.85
1889	64,723,110 (85,383,659)	1.11	25,863,230 (40,714,721)	1 75 ....

Between 1880 and 1889 the bituminous output increased 123.3% and the anthracite, 59.2%.

The pig iron statistics, extending only up to 1889, are now ancient history and hardly worth giving, as also the details for the other metals and minerals, of which 55 in all are separately listed, 11 being metals and 44 minerals. Only 7 metals and 12 minerals showed an output worth over $1,000,000 in 1889. Of the total for 1889 iron and coal alone accounted for $280,000,000, gold and silver for $99,000,000, copper for $27,000,000 and lead for $16,000,000, leaving only $165,000,000 for all the remaining 48 metals and minerals.

HIGHEST VIADUCTS IN THE WORLD.

In a late issue the New York "World" credits the Bureau of the American Republics with the statement that the so-called Antofagasta or Loa viaduct, in Bolivia, is 10,497 ft. long and has piers 3,736 ft. high. As an antidote against similar and too common bits of misinformation the following table has been prepared from published accounts in Engineering News and society publications. The table does not claim to include all viaduct structures over 200 ft. high, but we believe it correctly gives the chief data for the principal structures of this type:

Name.	Location	Total length, ft.	H't of ab've w't'r, ft.	Highest pier, top of foundation to top of pier, ft.	Character of pier, etc.
St. Giustina	Tyrol	197	460	1 span	No piers.
Garabit	France	1,852	406	199.2	Stone and iron.
Du Viaur (proposed)	"	1,508	382	.....	Iron arch.
Loa	Bolivia	800	336	314	Iron.
Pecos River	U. S. A.	2,180	328	321	"
Kinzua	" "	2,052	302	297	"
Kentucky River	" "	1,138	275	214.75	"
Verrugas (old)	Peru	575	256	252	"
Portage (old)	U. S. A.	820	235	.....	Wood.
" (new)	" "	850	235	203.6 / 31.4	Iron. Stone.
Moldau	Bohemia	886	214.4	205.4	"
Malleco	Chili	1,140	.....	243	Iron.
Souleuvre	France	1,200	247	200	Stone.
Two Med'ine	U. S. A.	751	211	.....	Wooden trest
Douro	Portugal	1,157	201	.....	Iron arch.

In the above list the St. Giustina bridge is used for a highway, all the others are for railways. The St. Giustina, Garabit, Du Viaur and Douro have arched main spans, while the others are trussed bridges, excepting only the old wooden Portage bridge, which may be classed as a trestle bridge of peculiar construction. It is difficult at times to obtain from the published descriptions the height of the iron pier separate from its stone base-pier. The pier-heights given above are therefore reckoned from the ground, or top of foundation proper, to the top of the pier, unless otherwise stated.

Tests of cellulose as a means of protecting warships from the results of shots near the water line are to be made at the Norfolk Navy Yard. This substance has the property of quickly swelling when wet so as to close up a hole made by any projectile before much water can pass through it. It is made from cocoanut fiber ground into meal and mixed with a proportion of entire fibers. It is formed into blocks which are hard outside but filled within with the loose meal. Cellulose has already been used to some extent in foreign navies for the above purpose.

A severe snowstorm on the evening of March 8 is reported to have suspended business in the greater part of Minnesota and the Dakotas. Telegraph lines are said to be nearly all down and railway traffic at a standstill.

The International Railway Congress will be held at St. Petersburg, Russia, in June. The meeting will last about two weeks, and a number of questions will be discussed relating to the construction, equipment and operation of railways, while there will probably be elaborate festivities. The Congress is composed of representatives of railways in every part of the world and representatives of a number of governments. The railways of the United States are very poorly represented, few roads taking sufficient interest in the matter to pay the small payments required for membership. The meetings of the Congress are held every two years. M. Belpaire, the eminent Belgian engineer, and Director General of the Belgian State Railways, is President of the Congress.

The cost of the new line which the Manchester, Sheffield & Lincolnshire Railway, of England, proposes to build from near Manchester to London is estimated at about $33,000,000 for 112 miles of railway, with stations and works. The cost per mile is estimated at $2,750,000 for the London section of 5 miles, $200,000 for the remainder of the line, or $300,000 per mile for the whole line. The land to be acquired is 1,475 acres, which will cost (including buildings) $12,780,000, about $7,000,000 of which is for 73½ acres for the London section.

PERSONALS.

Mr. E. W. Pratt has been appointed in charge of air brake inspection at the West Chicago shops of the Chicago & Northwestern Ry.

Mr. J. L. Blackwell has been appointed Engineer of Construction of the electric railway to be built by the Central Ry. Co., of Baltimore, Md.

Mr. J. B. Hutchinson, Superintendent of the Philadelphia, Wilmington & Baltimore R. R., has been appointed Superintendent of the New York Division of the Pennsylvania R. R.

Mr. J. F. Mann is Assistant Chief Engineer of the Illinois Central R. R., in charge of the Chicago Division and Southern lines. Mr. David Sloan is Assistant Chief Engineer, in charge of Western lines.

Mr. George P. Evans, General Manager of the Louisville, Evansville & St. Louis Consolidated R. R., has resigned, to accept the position of Superintendent of the Southern Division of the Boston & Maine R. R.

Mr. Theo. Low has been appointed Superintendent of the Durham Division (Eastern General Division), and Mr. D. H. Barger, Superintendent of the Winston-Salem Division (Western General Division) of the Norfolk & Western R. R.

Capt. W. W. Rich, M. Am. Soc. C. E., Consulting Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Marie Ry., has been appointed Chief Engineer, vice Mr. S. B. Fisher resigned. Capt. Rich was Chief Engineer during the construction of the road.

Mr. A. R. T. Lackie, C. E., formerly of the Engineering Corps of the Ontario Division, Canadian Pacific Ry., and more recently Resident Engineer of the Baltimore Belt Railway tunnel, has been engaged as Engineer for the Ingersoll-Sergeant Drill Co., of New York.

Mr. H. De B. Parsons, B. S., M. E., Consulting Mechanical Engineer, of 35 Broadway, New York, will give the course in Steam Engineering at the Rensselaer Polytechnic Institute this year, and the course in Railway Engineering will be given by Thomas M. Cleemann, C. E., of Philadelphia.

Messrs. S. M. and R. D. Rowe, M. Am. Soc. C. E., have opened an office under the title of Rowe & Rowe, at 130 Webster Ave., Chicago, Ill., as civil and consulting engineers. Mr. S. M. Rowe was chief engineer of the Needles Bridge, described in Engineering News of Sept. 28 and Oct. 4, 1890, and has been connected with the Atchison, Topeka & Santa Fé R. R. since 1878. Mr. R. D. Rowe is at present engineer of the South Chicago City Ry. Co.

Mr. Wm. L. Saunders, Secretary of the Ingersoll-Sergeant Drill Co., New York, was elected Mayor of the Borough of North Plainfield, N. J., March 8. Mr. Saunders is a capable man of affairs as well as a first-rate civil engineer, and will no doubt fill the office to which he has been elected with entire satisfaction to the electors. Mr. Saunders is the only civil engineer elected to the office of Mayor that we know of, except Mr. T. W. Jaycox, who was Mayor of Leadville, Colo., in 189C.

Mr. Russell Sage, 2nd., who lately died in this city, was born in Troy, N. Y., in 1839. He graduated from the Rensselaer Polytechnic in the class of 1839, and until 1861 was assistant engineer on the Troy & Greenfield R. R., and on the Hoosac Tunnel. From 1862 to 1868 he was assistant engineer on the Milwaukee & St. Paul R. R., and from that office worked his way up to the position of division superintendent. In 1878 he came to New York as an assistant to his uncle, Mr. Russell Sage, and was connected with him in many of his financial enterprises. He served about 18 months in the army during the late Civil War.

Rev. Noah Porter, D. D., the eleventh President of Yale College, died at New Haven, Conn., on March 4, aged 80 years. Dr. Porter was born in Farmington, Conn., Dec. 14, 1811, and was the son of the Rev. Noah Porter. He graduated at Yale in 1831, and was master of the Hopkins Grammar School, New Haven, and a tutor in Yale college until 1835, during which time he studied theology. On April 27, 1836, he was ordained pastor of the Congregational Church at New Milford, Conn., and held that charge until 1842, and a charge at Springfield, Mass., until 1846. In the latter year he was made the Clark Professor of Moral Philosophy and Metaphysics at Yale, and held that position until he was elected President of Yale in 1871, succeeding Dr. Theodore D. Woolsey. He resigned in 1886, and during the time he remained at the head of the college its advance in intellectual and material progress was very marked. Aside from the many philosophical and scientific works of which he was the author, he was perhaps best known as the principal editor of the revised editions of Noah Webster's Unabridged Dictionary.

NEW PUBLICATIONS.

MARCH MAGAZINES.—"The Forum" contains this month a popular summary of industrial progress in the South by Gen. E. P. Alexander, President of the Central Railroad of Georgia, who is quite optimistic on the prospects of that section. A notable thing in the article is the author's prediction that Southern seaports are destined to wrest a large share of the export trade from the cities of the North. In November last the exports from Southern ports, exclusive of Baltimore, amounted to no less than $45,538,391, out of a total of $110,100,220 for the whole United States, including the Pacific coast. Of course a great proportion of this was due to the enormous cotton crop of last year. The Intercontinental Ry. is discussed by Courtenay De Kalb. He attempts to make a favorable showing for the enterprise; but fairness compels him to acknowledge that the railway cannot compete with ocean transport between the Atlantic ports of the United States and those of Brazil, Argentine, and the Caribbean Sea, either in cheapness or speed of transport. He thinks, however, that traffic between interior points like Chicago, Kansas City, etc., might prefer an all-rail route, and he alludes to cheaper telegraph facilities, and the saving of the special packing necessary for ocean shipment as important points. The great mission of the Intercontinental railway, however, he believes, will be to connect the United States with the Pacific countries of South America, and with the little developed countries of Central America. The author omits to state, however, that the construction of the Nicaragua Canal will bring the Atlantic ports of this country about as near to Chili and Peru as they now are to Brazilian ports. The other articles in the number of special engineering interest are a brief paper on highway improvement by Col. A. A. Pope of bicycle fame, and an admirable paper, the best one of the four we have noticed, on the municipal government of Dresden, by Prof. F. G. Peabody, of Harvard College. The author does not claim that the administration of these German cities is perfect, but it certainly is immeasurably superior to the municipal misgovernment from which too many American cities suffer.

Papers by Julian Ralph continue among the chief features of "Harper's." One profusely illustrated article is devoted to a description of the Hudson Bay Company, and the inhabitants and resources of the vast unsettled portion of British America. The "Century" has a brief but good paper by Prof. Henry C. Adams, Statistician to the Interstate Commerce Commission, defending the State and National supervision of railway operations by means of commissions. He declares that "it is not more schemes or plans for the solution of the railway problem that are desired, but a more careful study and a more conscientious application of the [Commission control] plan to which the country has committed itself." We fully agree with him. An excellent paper on the work of the United States Fish Commission is among the illustrated articles.

"Scribner's" again offers something of especial interest to railway men in three papers discussing the limitations upon high speed in railway trains. Mr. M. N. Forney (who errs, we think, in allowing even for the sake of argument that 1,200 lbs. of water per sq. ft. of grate ever has been or ever can be evaporated from a locomotive boiler) explains how high speed is limited by the increase in train resistance and the capacity of the locomotive boiler and cylinder to do a greater amount of work than it is now doing. The logical deduction from his argument is that the present type of locomotive cannot give us very much higher speeds; but he briefly touches on some possibilities of future improvement which may yet make traveling at 100 miles per hour practicable "while some of us are left here to see it." Mr. Theo. N. Ely's paper is headed "Train Speed a Question of Transportation." After discussing the roadbed, rolling stock and signaling plant which will be necessary for safe running at 100 miles an hour, he points out the difficulty and expense in keeping the tracks clear of trains moving at ordinary rates to give right of way to trains running at this speed, and suggests that it will be necessary to give such trains separate tracks. This is the more apparent in view of the fact that distant signals will have to be set much farther from the home signal than on ordinary roads to make safe running at such speeds possible. In the third paper H. Walter Webb, Vice-President of the New York Central, discusses the fast run of Sept. 14 last, and the remarkable record which is being made by the Empire State express. The whole 436 miles in the great run was made in 426 minutes and the detailed schedule of the speeds at which the various portions of the run were made is as follows:

130 miles were run at less than 60 miles per hour.					
118	"	"	60 to 65	"	"
151	"	"	65 to 70	"	"
37	"	"	70 to 78	"	"

The chief features of the locomotives which are hauling this "fastest train in the world" are fireboxes on top of frames and of extra length, increased grate surface of 99¼ sq. ft., and increased heating surface of 2215½ sq. ft., weight of over 40 tons on four drivers, cylinders 19 × 24 ins., drivers 6 ft. 6 ins., and springs placed beneath axle-boxes instead of above them. In conclusion Mr. Webb denies that the fast train is more dangerous than other trains. Two other articles in "Scribner's" of especial interest to engineers are a description of the water route from Chicago to the Atlantic via the Lakes and the St. Lawrence, and an admirable article on laying out small country places, by Samuel Parsons, Jr., Superintendent of Parks of New York City.

In the "Popular Science Monthly" Carroll D. Wright continues his discussion of the Social Statistics of Cities, and Daniel Spillane gives a history of the development of the organ, in a paper which is of considerable mechanical interest.

"The North American Review" this month is devoted to political and economic, rather than technical, topics. Wm. E. Curtis, Director of the Bureau of American Republics, discusses "Our Commercial Relations with Chili." At present we import from her five or six million dollars worth of goods annually, and send her about the same amount; and Mr. Curtis thinks it "improbable that there will ever be any considerable amount of commerce between Chili and the United States." Her trade and social relations with England and Germany are too firmly established to be altered, except, perhaps, by the slow changes of years." Director-General Geo. R. Davis writes on the World's Columbian Exposition. No less than 62 foreign nations and colonies have already expressed their intention to participate in the Exposition, and their total appropriations amount to $4,000,000. Like a true Chicagoan, Mr. Davis winds up with a few words on the greatness of the "Windy City," which he justly thinks will be to many the most interesting exhibit of the Exposition. In the "Notes and Comments" a page is devoted to flying machines, with more sense and less nonsense in it than is found in most printed articles on this topic.

THE MECHANICAL ENGINEER'S POCKET BOOK of Tables, Formulæ, Rules and Data. A Handy Book of Reference for Daily Use in Engineering Practice. By D. Kinnear Clark; M. Inst. C. E., etc., New York; D. Van Nostrand Co. 16mo., flex. leather; pp. 655, 342 tables, 94 engravings, $3.00.

Few men having any use for a "Mechanical Engineer's Pocket Book" need to be told that Mr. Clark has shown himself to be perhaps as well qualified to write one as any man living, and is already the author of—not, exactly a pocket-book, for it is a very bulky volume, but of what is still the best existing "Manual for Mechanical Engineers," though it was first published as long ago as 1877, and has not since (to our knowledge) been materially revised or enlarged.

One's first and natural expectation, therefore, in taking up a new handbook on mechanical engineering by the same author, published 15 years after the first one was published, years which have been crowded full of every kind of mechanical advance and achievement, is to find in it the full fruition of what the first book merely promised. Had it been such, there would not have been in many years so valuable an addition to engineering literature, for the first book was a magnificent achievement: not without faults of omission, and, in a sense, of commission, but still a real and great contribution to knowledge.

But any such expectations as to the volume now before us will be grievously disappointed. It is a thin and poor production; so far as we can judge a mere "pot-boiler." It has some good points. No work from Mr. Clark's pen could well fail to have such, but, speaking in the large, what is good is not new, but a rehash of his former material, and what is new is not good, because it is so sketchy and fragmentary. This will quite clearly appear from the more detailed summary of contents, which is due to any work from Mr. Clark's pen.

The first 184 pages (29% of the whole) are occupied with elementary tables. We notice on p. 178 a singular misstatement: "In city measurements [in the U. S. A.] the inch ('foot,' apparently intended), is the unit, divided into tenths." As a matter of fact, sometimes feet and inches, sometimes feet and tenths, are used in our city practice. We know of no city where inches and tenths are the unit.

From p. 184 to p. 322, or to about the middle of the book tables of specific gravity and of the weight of bolts, pipes, sheet metal, weight and strength of beams, and the like are given. We notice an exceptionally full table of the densities of many alloys. There are three pages of telegraph details. Otherwise, though this part of the work may be more useful than any other standard English work, it is by no means so for this country. No part of the work so far reviewed will be of much use to Americans.

The next 100 pages are chiefly devoted to strength of materials. On ropes, chains and cables, the material given is pretty good, otherwise not much can be said for it. Not a date is given for any of the experiments, and Messrs. Kirkaldy and Fairbairn still cut the leading figure. Quite full information as to alloys of various kinds not to be found in other works of this kind is given, taken from the reports of the Alloys Committee of the Institution of Mechanical Engineers, of which Mr. Clark is (we believe), an active member. All the information on the "labor of men and animals," which the mechanical engineer is supposed to need to have handy is given in less than 11 lines, stating just four facts of observation.

We now come to the mechanical engineering department proper, which occupies the last third of the work. Mill gearing and shafting occupy 8 pages; transmission of power (both by ropes and electricity), 3 pages; heat (unsatisfactorily and inadequately treated as a whole, yet with some good points), 30 pages. We should have stated before that the type used is rather large and the page rather small, so that, at a guess, each page contains little more than half as much as a page of Trautwine.

A very good and useful table in the "Heat" department is one on the linear expansion of solids from heat. It includes many substances like brick, mortar, concrete glass and various stones and woods not to be found in many like compilations. Yet it illustrates the sketchiness of the work, that the moduli of elasticity of the same substances, or even of the leading metals, are not to be found in the book.

To "Combustion" only 4 pages in all are devoted, including a brief table of the heating value of fuels. It goes without saying that the article must be superficial. "Warming and Ventilation" occupies 7 pages, and what there is is good. "Steam" occupies 34 pages, tables and all, and is also pretty good, though necessarily somewhat superficial. "Railways" (14 pages) is purely English, mostly ancient or merely statistical, and of little worth. "Electric Propulsion on Railways" is treated in 12 lines, the only basis of fact being (if we judge correctly from internal evidence, though no reference is given) Mr. Moss' recent paper before the Am. Soc. C. E., detailing some experiments on the elevated lines which, though correct so far as they went, ought by no means to be taken as indicative of the true state of the art, still less of future possibilities.

From p. 548 to p. 597, "Steamships" (6 pages), "Pumping Engines" (5 pages), "Coal Gas" (7 pages), "Gas Engines" (3 pages), "Air in Motion" (4 pages), "Compressed Air" (6 pages), "Refrigerating Machinery" (1 page), and various hydraulic formulas (14 pages) are discussed, perhaps as fully and as well as the space taken permits, but necessarily in a rather superficial way. About half the space is taken up with tables, and in setting them up economy of space seems to have been little studied.

The remaining 43 pages of the book are devoted to "Electrical Engineering," in which all departments of electrical work are touched upon. We judge this department to be pretty well done. It seems concise and useful.

An index of 16 pages closes the volume, for which the best that can be said is that mechanical engineers will probably find it useful for occasional reference, though it is quite unworthy of its author or of its title. It is but fair to note that the work is written more for English than American use, and English engineers are not nearly as well supplied as are American with other existing pocketbooks. It will therefore be much more useful, and probably much more appreciated there than here; but after making all allowances for this difference, it remains a pretty thin production. The publishers have made a mistake of judgment in using too thin paper, but otherwise they have done their work well.

PRACTICAL ELECTRICAL ENGINEERING. A Complete Treatise on the Construction and Management of Electrical Apparatus as used in Electric Lighting and the Electric Transmission of Power. By W. W. Beaumont (gearing and power), C. H. Biggs (general editor), C. Capito (engines and wires), G. Kapp (dynamos), M. H. Kilgour (distribution), A. Reckenzaun (tramways, secondary batteries), R. P. Sellon (arc lamps), J. Swinburne (incandescent lamps), and H. Swan (wiring and fittings). In 2 vols. Vol. I. London: Biggs & Co.; New York: J. Arnot Penman, 7 Warren St. 4to, pp. 384, 178 engravings. $7.50 per volume, or 75 cts. per part, in 18 parts.

This is certainly an elaborate and ambitious publication, and we should judge was likely to be of real value to electrical engineers on both sides of the water, though it is difficult to judge conclusively from the first volume only, in which a very large proportion of the space is occupied by what is almost a separate treatise on the steam boilers and engines, which enters into details which would seem hardly appropriate in an electrical treatise, though the expert electrical engineer has need of it of course. The volume also has the disadvantage that it makes English electrical practice, which is on the whole less advanced than American, disproportionately prominent.

The general scheme of the work is a good one, to have each department of electrical knowledge written up by a man expert in that department. The nine different authors are all members of the Institution of Electrical Engineers or (in one case) of the Inst. C. E., and so far as we can judge from those who contribute to the first volume, they will all do their work fairly well except the general editor, who seems to lack a just sense of perspective in regard to the space to be devoted to the several subjects.

This will be readily seen by running over the contents more in detail; though, by the way, there is no table of contents; only a fairly good index. The first 46 pages are devoted to elementary electrical principles, including a chapter on electrographics. Then we stop short as to electrical matters proper, and do not resume them until page 265, no less than 220 pages out of the 384 in the volume being devoted to treatises on foundations, buildings, boilers and engines. "Foundations considered practically," bricks, mortar, concrete, etc., occupy 15 pages. It is a pretty good chapter, and largely devoted to methods of neutralizing the effects of tremor, yet it seems out of place.

Then we enter upon 90 pages on steam boilers, which begins at the foundation with the important announcement: "A boiler is a closed vessel which contains partly steam and partly water. Steam is produced by applying heat to the water, whereby the temperature of the water rises, becoming greater and greater the more heat is added." By the second or third page, however, we reach less elementary facts, and we are bound to say that a very good illustrated summary of modern boiler practice follows, including much detailed information on incrustation and like topics which, if a little out of place in this book, are nevertheless likely to be useful.

Then we come to "Principles of Dynamics," opening with a definition of mass; then a chapter on heat; then on the theory of the steam engine, indicator practice, etc. This kind of matter, which is pretty well compiled and presented, contains absolutely nothing peculiar to electrical practice, occupies some 50 pages, and is followed by some 60 pages of steam engine details, chiefly confined, of course to engines for driving dynamos. It illustrates the British limitations of the editorial vision that the Westinghouse, Ball and Armington & Sims engines are not even casually referred to in this certainly ample department of steam engine practice: and even British practice seems to be somewhat unequally treated, the firm of Davey, Paxman & Co. being more easily in the lead of all others in this volume than we understand them to be in fact.

Resuming electrical details proper at p. 265, the last 120 pages of the work are divided between "Switches and Switch Boards" (26 pages), "Measurement of Electricity" (62 pages), and "Electric Light Mains" (31 pages). Each of these subjects seems to us to be treated very well, the two last especially. They are too exclusively British, and thus miss some of the latest and best features of electrical practice, but this is an evil which must be accepted and allowed for, and is to a certain extent natural and unavoidable. The greater portion of the strictly electrical matter has yet to follow in a second volume, and we must postpone expressing any final opinion upon the work until that volume appears.

DIRECTORY OF THE IRON AND STEEL WORKS OF THE UNITED STATES. Embracing a Full List of the Blast Furnaces, Rolling-Mills, Steel Works, Tin-Plate Works and Forges and Bloomeries in the United States. Also all the Cut-nail Works, Rod Mills, Wire-nail Works, Wire Mills, Car-Axle Works, Car Wheel Works, Car Builders, Locomotive Works, Cast Iron Pipe Works, and Wrought Iron Pipe Works. To which is added a Complete List of the Iron and Steel Works of Canada and Mexico. Philadelphia, American Iron and Steel Association. Corrected to February, 1892. 8vo, pp. 282.

The present edition of this useful work differs from its predecessors in adding to its wealth of statistical information, a list of the tin plate works established in the United States since Oct. 1, 1890, and the lists for Canada and Mexico. But many of the older features have been enlarged by giving fuller information, especially concerning wire-nail works and wire mills, the capacity of locomotive works, car and pipe works. A fuller abstract of the contents of this volume is given elsewhere.

HOW TO RUN ENGINES AND BOILERS: Practical Instruction for Young Engineers and Steam Users. By Egbert Pomeroy Watson, Editor of "The Engineer." Published by the author. Cloth, 12mo., pp. 125, 23 illustrations. $1.50.

This is an elementary book designed for the instruction of those inexperienced in the running of stationary engines. Most of the book is devoted to the plain slide-valve engine, and the Corliss type is not described at all. The author seems to us to counsel rather too much tinkering with the engine by the engineer, especially when he advises as a first step on taking charge of an engine to take off the cylinder heads and bolt a filling plate onto the inside of the head to reduce the clearance, provided it is found excessive. While this is all right theoretically, it is not every man in charge of an engine who is competent to determine what clearance is necessary, and the result of giving too small clearance would hardly be pleasing to the engineer or his employer. The book contains, however, a good many practical "wrinkles" which may be useful to any engineer.

DIE BEDINGUNGEN EINER DAUERHAFTEN SCHIENENSTOSS-VERBINDUNG (Requirements of a Durable Railjoint), by Dr. H. Zimmermann. Berlin, 1892. W. Ernst & Son. 8vo, pamph., pp. 20; 10 illustrations.

This is an interesting treatise upon rail-joints in general, comparing the different methods used, illustrating the advantages and defects of each in a graphical and concise manner and giving practical hints on the improvement of the present system. It is supplemented by tests made by the German State Railways upon different types of rail-joints.

MINERALS. A Monthly Magazine. Wm. M. Goldthwaite, New York. $1 per year.

This is a new monthly, interesting in its treatment of a seemingly dry subject, and interspersing with useful information on minerals much gossip under this head. A list of new minerals is given in each number.

IRRIGATION AND RECLAMATION OF ARID LANDS. Report of the Special Committee of the U. S. Senate. Wm. M. Stewart, Chairman. Four volumes in two, pp. 459, 573, 608, 386; maps and illustrations.

These volumes, with their total of over 2,000 pages, contain a great deal of matter of interest and value to engineers and irrigationists, although many pages are taken up with testimony that adds absolutely nothing to the information on the subject. The volumes were first issued some months ago, but the edition was soon exhausted. We understand that 15,000 additional volumes were recently made available for distribution and would advise any one desiring the reports to make early application for the same to their representative in Congress.

The first three volumes give majority and minority reports of the committee and the testimony taken by the committee on their trip of some 14,000 miles through the Western States.

The fourth volume is made up as follows: Statements by Director Powell and other officers of the U. S. Geological Survey; Reports of United States Consuls in Countries Using Irrigation; Miscellaneous Papers on the Subject of Reclamation; R. J. Hinton's Report on "Irrigation in the United States," Re-edited by Order of the Committee.

The reports of the U. S. Consuls, about 35 in number, contain some valuable information regarding irrigation in other countries. Mr. Hinton's original report on "Irrigation in the United States" was noticed in these columns some time ago.

Abstracts of federal, state and territorial court decisions regarding the use and control of water in the arid region occupy 26 pages of Volume IV., and will be of great value to all interested in such decisions, especially as the decisions are alphabetically arranged by subjects.

The reports are accompanied by many maps and by a few diagrams and illustrations. Each volume is well indexed.

PENNSYLVANIA STATE BOARD OF HEALTH. Report for 1890. Benjamin Lee, M. D., Secretary. 8vo., pp. xi., 740; plates.

A paper on the "Drainage and Sewerage of Norristown," by P. J. Eisenberg, gives a history of sewer construction in that city, which has extended over some 40 years, but which when the paper was read, in 1889, included only two miles of sewers, designed more for the removal of storm water than sewage, and with no provision for ventilation. An article on the "Purification of Water Sup-

plies," by C. W. Chancellor, M. D., Secretary State Board of Health of Maryland, reviews the various methods of purifying water. An article by Henry B. Baker, Secretary State Board of Health of Michigan, on "Sulphurous Disinfection," is illustrated by a sheet of drawings showing a sulphurous oxide furnace designed by Dr. Joseph J. Kinyon, Assistant Surgeon Marine Hospital Service. Another large folding sheet shows a plan and sections of a fumigating tug for the Louis Pasteur Quarantine Station, U. S. Marine Hospital Service, at the mouth of Delaware Bay.

STATE MINE INSPECTOR OF THE STATE OF MISSOURI. Fifth Annual Report, for the Year ending June 30, 1891. Jefferson City, Mo., 8vo, pp. 215, tables and illustrations.

This report of Mr. C. C. Woodson, the State Inspector of Mines, contains the statistics of the coal, zinc, lead and iron industries in the State of Missouri, with a general description and location of each mine. The report shows a mineral output valued at $8,165,865, and a total of 12,392 persons directly employed in these industries. This output for 1891, included 2,650,018 tons of coal; 16,925 tons of lead ore, 19,968 tons of pig lead, 123,752 tons of zinc ore and 138,356 tons of iron. Out of a total of 1,012 accidents of all kinds in the year, with 12,392 persons employed, 30 men were killed and 55 injured. The aggregate value of the lead and zinc produced was $5,081,462, with an average value per ton at the mines of $49.10 for lead ore, and $21.69 for zinc ore.

GEOLOGICAL SURVEY OF MISSOURI. A Preliminary Report on the Coal Deposits of Missouri, from Field Work prosecuted during the Years 1890, 1891. By Arthur Winslow, State Geologist. Geological Survey. 8vo., pp. 226; 131 illustrations and maps.

The National Railroad of Tehuantepec is to be completed in accordance with a concession just granted by the Mexican Government to the following syndicate: Mr. C. Stanhope, London; Mr. E. L. Corthell, Chicago, and Mr. Joseph H. Hampson, Kansas City. The work suspended last summer under a former contract is to be renewed and vigorously pushed, with the expectation of opening the route within the next 15 months. It is understood that the Government intends to improve two harbors and make this a first-class route. The office of the syndicate is 13 San Juan de Letran, City of Mexico.

TRADE PUBLICATIONS.

CALIFORNIA REDWOOD WATER PIPE.—The Excelsior Redwood Co., San Francisco, Cal. 16mo, pamph., pp. 63. Its Construction and Laying.

The bulk of this pamphlet, issued to describe redwood, is made up of a useful series of tables based on Kutter's formula, treating of the flow of water in wooden pipes. These tables range from 12-in. to 120-in. pipe, and give the velocity and friction heads and velocity and discharge, the latter in cubic feet per second and million gallons in 24 hours. It is a handy little book. This kind of pipe, as used at Denver, Colo., was described and illustrated in Engineering News Sept. 22, 29, 1888.

ELECTRIC LIGHT AND STREET RAILWAY POLES.—Illustrated Catalogue of Patent Poles; Milliken Bros., New York, 1892; large 8vo., pp. 38.

This catalogue contains descriptions and illustrations of different styles of the Milliken steel poles for carrying electric railway and light wires, several good views on streets where these poles are in use, and a report of tests made at Ithaca, N. Y., with Milliken and metal pipe poles. The Milliken pole was illustrated and described in our issue of May 3, 1890.

CORRUGATED AND OTHER SHEET METAL.—Illustrated Catalogue of the Cincinnati Corrugating Co., Cincinnati, O., 1892. Paper, 8vo., pp. 48.

In addition to corrugated metal roofing, siding, shutters, etc., the company makes various kinds of metal roofing, weather boards, cornices, gutters and other building material, including roofing tin plates and galvanized sheets. Metallic red paint for roofing is also supplied.

CEMENT.—A Revised Edition of the Treatise prepared and presented by the Lawrence Cement Co. of New York.

This is a handy little book of 36 pp., giving a sketch of the Rosendale cement industry, methods of testing, directions for mixing and using, notes on sand, cement, mortar, concrete and its mixing, grout, etc.

WELL AUGERS AND DRILLS. A Descriptive Catalogue and Price List of the Peck Manufacturing Co., Sioux City, Iowa. 8vo., pp. 63, fully illustrated.

Fully describes and illustrates, with prices, outfits for artesian well boring, rock-drilling machines, well augers, from 12 to 24-in. diameter, and the various tools and appliances in operations of this character.

CHAIN BLOCKS. Pamphlet issued by The Yale & Towne Mfg. Co., of Stamford, Conn.

It describes and illustrates the Weston "direct" differential pulley block, and gives tables of their capacity, hoist, price, etc. The Weston "triplex" spur-gear block is treated of in a similar manner. An abstract of Prof. R. H. Thurston's report on the tests of efficiency of chain blocks is added.

WATER TUBE SAFETY BOILERS.—The Sterling Co., Chicago, Ill. 8vo. pamph., pp. 40.

The Sterling boiler, described herein, consists of two or more upper drums or cylinders, with the steam spaces connected by pipes, and each drum having water tubes running to a mud drum behind the grate.

SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on March 1, President Johnson in the chair and 23 members and 2 visitors present, the secretary read a communication from Mr. O. Chanute, inviting the members of the club to attend and take part in the International Congress for Internal Navigation, at Paris, France, in July. Mr. J. A. Laird described the character of the cast iron used in the Worthington engines at the St. Louis water-works. The specifications and tests applied were described and specimens exhibited. Arthur Thacher, Secretary.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The quarterly meeting was held at Youngs' Hotel, Boston, Mass., Wednesday afternoon, March 8. President H. J. Holden, of Nashua presided. Some minor business matters were attended to, but the greater part of the session was devoted to the "experience talks" which are proving so helpful to the members. Before commencing the talks the president called upon Mr. M. N. Baker, Associate Editor of this journal for remarks. Mr. Baker called attention to the fact that meters are growing in favor, and must soon be used very generally, particularly as filtration is also coming into use, and filtered water, especially, should not be wasted. The first "talk" was by Mr. Desmond Fitzgerald, Brookline, Mass., who outlined the contents of a French Work, by M. Violeine, on sinking funds, with tables worked out to eight places of decimals. This work costs in this country about $3.75, and the speaker considered it of great value as a labor saver.

Mr. Solon M. Allis, Malden, next spoke on "Economy in Water-Works Management," recommending standard sizes for corporation cocks, and other fixtures; the providing of proper storage for water-works material; that no mains be laid in new streets until a grade has been established and a profile made.

Mr. Geo. C. Chace, Taunton, Mass., gave an account of the laying and use of a direct intake pipe to admit water to the filter gallery, when necessary, the water to be mixed with that which has been filtered.

Mr. F. F. Forbes, Brookline, Mass., presented the result of experiments to determine the friction in a force main at Brookline, showing a greater actual frictional head than that obtained by Fanning's formula. This, Mr. Forbes thought, is largely accounted for by the roughness of the interior of the pipe, which had been in about 18 years, and was somewhat rusted. Mr. Forbes recommended that in designing works allowances be made for just such reductions in capacity as the above.

Mr. F. L. Fuller, Boston, made some remarks regarding a well built in the summer of 1891, to increase the water supply of Waltham, Mass. The well was sunk in the filter basin from which the supply is obtained, and was carried to a depth of 18 ft., the diameter being 40 ft. in the clear. The well was sunk on a shoe and has a masonry wall.

The next talk was by Mr. S. P. Griffin, Lowell, Mass., who described the manner of laying a new 30-in. supply main for the Lowell works.

Mr. L. A. Taylor, Boston, related an experience with a water meter placed on the pipe supplying his house. Before the meter, which had been in service about five years, was put in place it was tested and found in fair condition. By the use of the meter small leaks were detected and the consumption was finally reduced about one-third by stopping the same.

Mr. A. F. Noyes, West Newton, referred to a discussion brought up at the last meeting by Mr. E. H. Gowing, Boston, regarding uniform forms of specifications and contracts. Mr. Noyes thought that this was impracticable except in a few particulars always similar in character. Some discussion followed the remarks of Mr. Noyes, as was the case with most of the talks. Mr. Gowing supported his position by stating that architects use standard specifications, and that it seemed to him that water-works engineers could do the same.

THE WESTERN SOCIETY OF ENGINEERS.—At the last meeting, President Isham Randolph in the chair, 50 members were present. A communication from Mr. Francis W. Parker, chairman of a committee of the Chicago Electric Club, was presented, asking the appointment of a committee from the society to act with their committee and one from the Society of Architects in formulating a plan whereby the three societies may co-operate in securing a suitable equipment for a laboratory, workshop and museum for a technological institute. The letter further stated that the philanthropists and capitalists of Chicago would contribute liberally to the building of such an institute to cost $250,000; $150,000 for a physical laboratory building; $50,000 for a museum of mechanical art connected therewith, and $50,000 for additional equipments.

It is thought, in view of the coming of the World's Fair and the general activity in engineering interests, that it will not be difficult to secure vast quantities of material desired for the purpose at practically no expense. The Electrical Club speaks very positively for the electrical industries, to the effect that they will furnish, free of cost, substantially everything necessary to equip a physical laboratory, so far as such an institution may need material and appliances made by manufacturers of electrical machinery.

The scheme has received the hearty indorsement of the Chicago University, which has offered to start immediately a complete technological institute, and furnish grounds and all of the expenses, including salaries and the like, if the citizens of Chicago will give them the buildings above proposed and the apparatus and equipment for such laboratory and museum as above suggested. The University has already secured $150,000 for a chemical laboratory, and proposes, in like manner, forthwith to establish their chemical department and expend thereon $12,000 to $13,000 per annum. It is confidently asserted that not less than $500,000 in the Ogden estate will shortly be available and at their disposal for instruction in pure science.

It is proposed to establish, immediately, some or all of the engineering courses, and to put at the head a first-class professor of physics, at a salary of $7,000, and to expend on the engineering courses proper, about $15,000 to $16,000. It will spend $10,000 to $11,000 annually on the mathematical courses, making in all about $37,000 yearly as a beginning in the field of technical education.

The proposition was received and favorably discussed. The president was authorized to appoint a committee of seven to act in this connection.

A letter from Mr. O. Chanute was read, inviting the members of the society to attend the Fifth International Congress for Internal Navigation, to be held at Paris, France, beginning July 21, 1892, continuing 10 days. It is desired to have a large number of American Engineers in Paris at this Congress, and it was hinted that their presence would do much toward inducing reciprocity toward our own Engineering Congress in 1893.

A letter from Mr. E. L. Corthell regarding the World's Congress Auxiliary was read, stating that printed circulars explaining what had been planned in regard to organizing the proposed Engineering Congress of 1893, have been sent to the society, and desiring to know whether the proposed plan meets its approval.

Mr. G. A. M. Lillincrantz was appointed chairman of the committee on badge, seal and diploma.

A paper was read on "The King of Salt Lakes," by Mr. Geo. W. Wait. Mr. A. Gottlieb presented a paper on "The Behavior of Iron Columns at High Temperatures," abstracted from one read by Engineer R. Luchman before the Society of Engineers and Architects, at Hamburg.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF KANSAS CITY.
March 14. Baird Building. Secy., H. Goldmark.
WISCONSIN POLYTECHNIC SOCIETY.
March 14. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
WESTERN RAILWAY CLUB.
March 15. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
March 15. Secy., J. H. Harlow, Pittsburg, Pa.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
March 15. Secy., R. W. Pope, 12 W. 31st St., New York. "Lightning Arresters," A. Wurts.
BOSTON SOCIETY OF CIVIL ENGINEERS.
March 16. Secy., S. E. Tinkham, City Hall.
ENGINEERS' CLUB OF ST. LOUIS.
March 16. Secy. Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
March 16. Secy., F. Collingwood, 127 East 23d St., New York.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
March 17. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
March 17. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
March 17. Secy., T. G. Pihlfeldt, 118 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
March 17. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
March 17. Secy., H. G. Prout, 73 Broadway.
MONTANA SOCIETY OF CIVIL ENGINEERS.
March 19. Secy., F. D. Jones, Helena.
ENGINEERS' CLUB OF PHILADELPHIA.
March 19. 1122 Girard St. Secy., J. C. Trautwine.
CENTRAL RAILWAY CLUB OF BUFFALO.
March 24. Secy., Jas. Macbeth.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 1. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 1. Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
April 2. Secy., P. Valentine. At 391 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
April 12. Union Station, St. Paul.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 4. Secy., C. L. Annan.
WESTERN SOCIETY OF ENGINEERS.
April 6. Secy., J. W. Weston, 280 La Salle St., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
April 7. Public Library Bldg. Secy., F. W. Cappelen.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 8. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
April 9. 194 Third Ave. Sec., H. Schreiter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 9. At Roanoke. Secy., J. E. Schiet, Roanoke, Va.
DENVER SOCIETY OF CIVIL ENGINEERS.
April 13. Secy., Geo. H. Angell, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 12. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 12. Secy., A. H. Porter, 50 Euclid Ave.
NORTHWESTERN SOCIETY OF ENGINEERS.
April 12. Occidental Block, Seattle. Secy., E. H. Warner.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
April 14. Secy., O. H. Landreth, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 14. Secy., Edward Mead, Norton Building.
NEW ENGLAND RAILROAD CLUB.
May 11. United States Hotel, Boston. Secy., F. M. Curtis.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 12 W. 31st St., New York.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Tuesday afternoon; new advertisements, Wednesday afternoon; transient advertisements, not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The laying of a considerable section of 100-lb. rails on steel ties is so novel and significant a step forward that we think it worth while to call especial attention to the drawings of the tie and (if finished in season) of the rail which is about to be laid down on the four tracks of the New York Central & Hudson River R. R., between Mott Haven and the Grand Central Station. This will be the first 100-lb. rail ever rolled in this country and, with the exception of that laid through the St. Clair tunnel and the 110 lb. rail on the Chignecto Ship Railway, the first laid on this continent. We may be quite sure, however, that it will not be the last, as many other railways besides the N. Y. Central are beginning to feel keenly the inconvenience of having to make renewals on tracks crowded with traffic. More and more of them will be willing to spend a good round sum once for all to get such tracks in shape to "stay put" for several years; as also to reduce to the minimum the chance of a derailment from a broken rail, such as occurred only a few days ago in the Grand Central tunnel, and, though not generally realized, narrowly missed causing a terrible disaster of a kind against which no human foresight can ever perfectly provide; namely, that caused by a derailed train on one track obstructing the other just as another train is approaching. The consequences of such a disaster in a tunnel may be indeed terrible, and yet no one be to blame. On the Grand Central approach tracks, the only time available for making the necessary alterations and preparations for the new track is between 9 p. m. and 6 a. m., when two tracks out of the four are turned over nightly to the trackmen.

The giving away of franchises to water companies seems likely to be stopped in Massachusetts. Four bills providing for the incorporation of private water companies have been before the Massachusetts Legislature for some time, and all were nearly through the house when a discussion arose, headed by Speaker Barrett, over the provision for the purchase by the town of Methuen of the franchise and other property, the company intending to operate there. Mr. Barrett urged that franchises belong to the public and should be used for the public interest. Several other members supported Mr. Barrett, and finally all four of the bills were ordered to be reconsidered. It appears that the bills have since been so amended that towns purchasing works of the companies in question will not pay for the franchises which they have formerly transferred to the companies. In addition the amended bills provide that in case of purchase by the town the company shall be guaranteed 6% on their investment, the town to make up the deficit, if any, between actual net earnings and 6%. In other words, it appears that the works will be sold at cost plus whatever may be necessary to give 6% on the investment. Some such arrangement for determining the franchise price and a strong stand on the part of the State Legislature and City Councils against paying for franchises previously given away for nothing are eminently wise and just, and should be more generally made.

The work of the Irrigation Inquiry, Department of Agriculture, which has been carried on under the direction of Special Agent Richard J. Hinton, has received a setback that we earnestly hope will be only temporary. The First Comptroller of the Treasury has decided that the balance of the small appropriation of $10,000 is not available for the inquiry because under Judge Mathews' ruling it is limited by the same time conditions that closed the artesian and underflow investigation Jan. 1, 1892. The Secretary of Agriculture regarded the appropriation as continuous for the fiscal year ending June 30 next. None of it was expended till after July 1, 1891, and only about $4,000 now remains. It was probably the Senate's intention—in which body the appropriation originated—to make the same a continuous one, but the introduction of a semicolon in place of a period between two clauses of the same section makes the interpretative legal mind decide otherwise. The matter is not one of hostility in any way to the work of the irrigation office. It is proposed to put a provision into the pending urgent deficiency bill allowing the small balance to be expended as the Department of Agriculture deems best. No doubt is felt of its passage. An effort will also be made, we are informed, to secure the inclusion in the regular agricultural appropriation act of a provision making the office of Irrigation Inquiry a permanent division of the Department of Agriculture with a moderate annual appropriation of from $10,000 to $15,000. It is to be hoped this will become law. The Irrigation Inquiry's work under Colonel Hinton's charge has been fruitful of excellent results, as we have already stated in noticing the progress reports which have been published.

There are now in the Government Printing Office, in process of rapid preparation for publication, three "final" reports, besides that of Mr. Hinton, on the Irrigation Inquiry proper. These three reports close the Artesian and Underflow Investigation, and have been prepared by Chief Engineer, E. S. Nettleton, of Colorado, and his assistant, Mr. W. W. Follett; by the Chief Geologist, Robert Hay, of Kansas, and his assistants, Profs. Culver, of Dakota, Hicks, of Nebraska and Hill, of Texas. In addition there are two special reports included with the others, by J. W. Gregory, of Kansas, and B. B. F. Coffin, C. E., of South Dakota. The total cost of this great amount of work, done within nineteen months, has been about $65,000. In view of the value of the reports now being printed, Senator Manderson, Chairman of the Committee on printing, seems justified in saying that "a vast amount of information has been gathered by exceptionally competent agents of the Government, and that the reports should be widely circulated."

The valuable series of tests of timber which has been undertaken by the Forestry Division of the U. S. Department of Agriculture has been described and commented upon in previous issues, and a bill is now before Congress, introduced by Mr. John R. Fellows, authorizing an appropriation specially for this work. In view of the great importance of these tests, and the value of the recorded results to engineers, architects, builders, and such persons, it is to be hoped that the bill will be passed. We have received advance sheets of the first of a series of bulletins which are to record the results of an extensive investigation into the nature of our important woods, especially their mechanical and technical properties, and the dependence of these upon structure and physical condition and upon the conditions under which the wood was grown. This bulletin has been compiled by Mr. B. E. Fernow, Chief of the Forestry Division, and makes a very clear showing of the need of the investigation, giving instances of great and continued waste of timber owing entirely to the fact that the value of the timber was not understood. In Alabama, chestnut oak was felled for its tan bark, the wood being left to rot, until the Forestry Division a few years ago called attention to the value of the wood for railway ties, since which time it has been extensively used for this purpose. The timber of the long leaf pine of the South, cut after a tree has been "boxed" for turpentine, is generally supposed to be much deteriorated by this process of gathering the turpentine, but while the withdrawal of the resinous matter does probably reduce the capacity to withstand rot, in some parts of the tree at least, it was not considered by those in charge of the investigations that the strength in general should suffer, and tests conducted under the charge of Prof. J. B. Johnson are said to point to the conclusion that the "turpentine" timber seems to possess greater strength than timber from unboxed trees. A strong argument in favor of providing the means for continuing the comprehensive system of investigation already outlined is contained in a large number of letters from prominent engineers, which are appended to the bulletin above referred to, and which point out the various practical and economic advantages from different points of view. Owing to the great scope of the work and the length of time which will be consumed, the investigations cannot be undertaken by individuals, and it appears eminently proper that the government should undertake them and provide means for properly carrying them out.

The paper by Mr. Wm. Forsyth on the strength of M. C. B. couplers, published in our last issue, deserves careful consideration by coupler manufacturers and railway men. He states the percentage of annual breakages in two years' experience on the Chicago, Burlington & Quincy as 7% for the couplers and 24% for the knuckles. Our statistics of Janney coupler breakages on nine different railways having over 22,000 cars equipped (among them the C. B. & Q.) published about two years ago (Feb. 15, 1890) showed average breakages of 2.75% for couplers and 4.14% for knuckles. The Standard Coupling Co. claims that the improved Dowling type of coupler on the New York Central averages 3.39% annually of coupler breakages and 12.54% of knuckle breakages. In the same connection they claim that a rival coupler has shown on that road 27.87% of breakages per annum in the couplers and 54.59% in the knuckles. For more convenient comparison we arrange these figures in tabulated form:

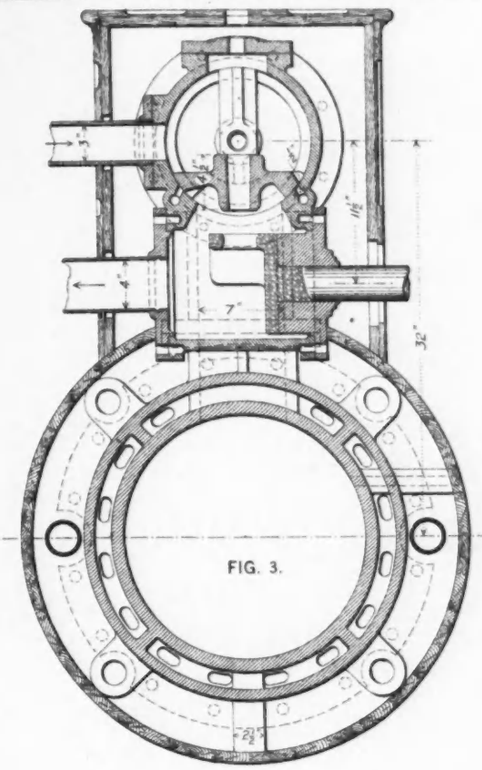
	Percentage of annual breakages in: Couplers.	Knuckles.
Ave. of 9 roads, records pub. Feb., 1890.....	2.75	4.14
C., B. & Q., 2 yrs., 1,184 to 9,205 cars equipped.....	7.00	24.00
Standard, N. Y. Cent., 5,338 cars equipped	3.39	12.54
"Rival" coupler, 5,931 cars equipped.....	27.87	54.59

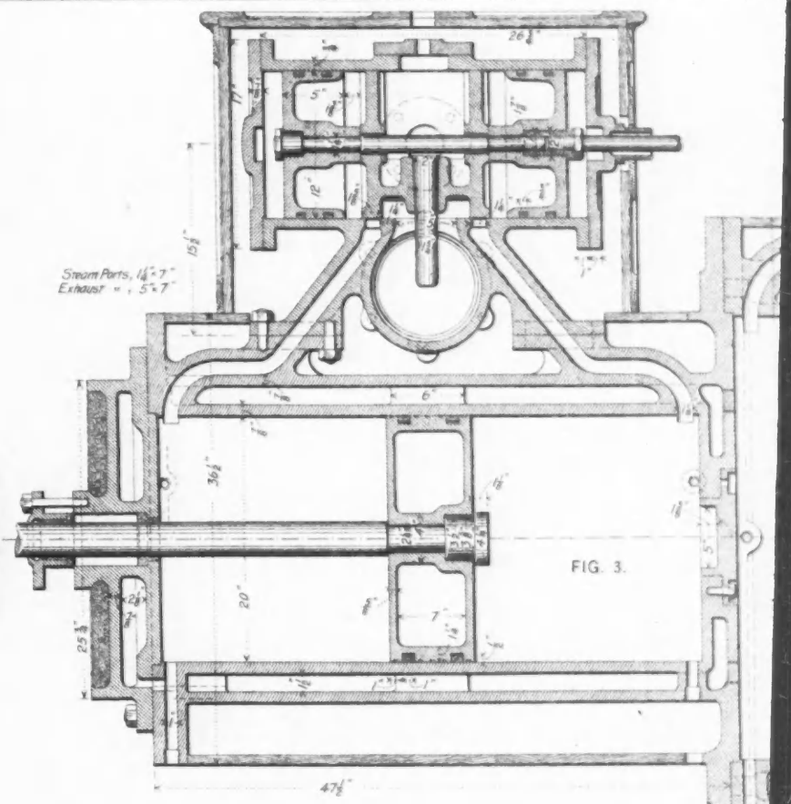
The natural conclusion from the above figures is that there's odds in couplers, and also that the percentage of breakages of both knuckles and couplers has greatly increased.

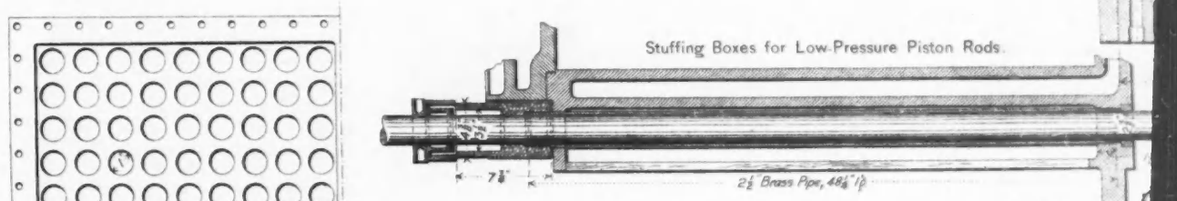
It is still true that the cost of maintenance, considering the fact that a large proportion of the breakages are made good by the manufacturers, is no excessive sum, even with a percentage of breakages as great as that on the C., B. & Q.; yet the proportion of breakages, of the knuckles especially, is far too high to be considered creditable. Mr. Forsyth proposes to reduce breakages by making both coupler and knuckle of cast steel, instead of making the coupler of malleable iron, a change which a few of the coupler manufacturers have already made. He would also protect the coupler by the use of buffer blocks or perhaps spring buffers on each side of the drawbar.

What the railways want is strong couplers made of the best material, not a half dozen new ways of locking and unlocking the coupler or connecting its parts together. A few manufacturers recognize this and, we believe, are making an effort to turn out the strongest couplers they can. Most of the new candidates for favor, however, are relying more on patents covering some new-fangled style of locking or the like than on excellence of manufacture. It is a pity that all such do not more fully realize that the coupler question is not now a question of new invention, but one of manufacture. Any maker of malleable or steel castings is now at liberty to make couplers which will conform to the M. C. B. standard, though perhaps many of them do not realize that fact. There is really an opportunity for a large and profitable business in this connection, especially if equipment with M. C. B. couplers is made compulsory.

Making the draw bar of steel, however, will not help the knuckle fractures much, since most knuckles are already made of steel, though perhaps not of as good steel as they might be. The great desidera-







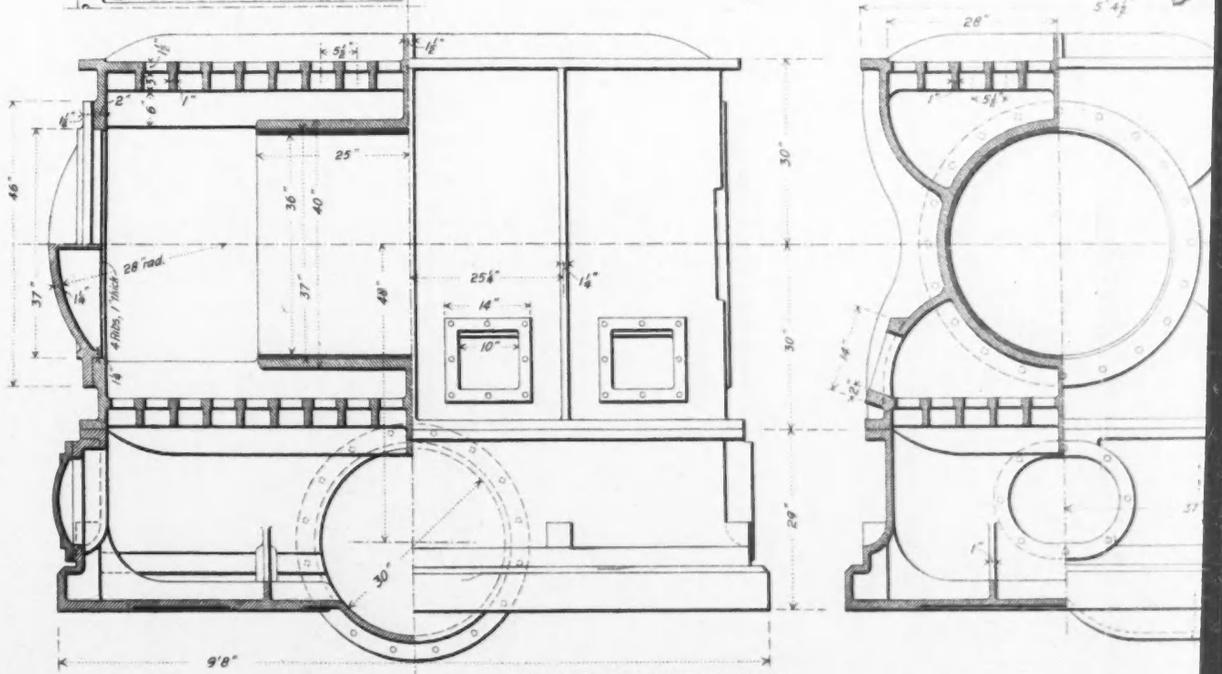


FIG. 6. DETAILS OF PUMP END.

TRIPLE-EXPANSION CONDENSING PUMPING EN

Designed and

FIG. 3. LONGITUDINAL AND CROSS SECTIONS

FIG.4. LOW-PRESSURE CYLINDER.

FIG. 5. HIGH-PRESSURE CYLINDER.

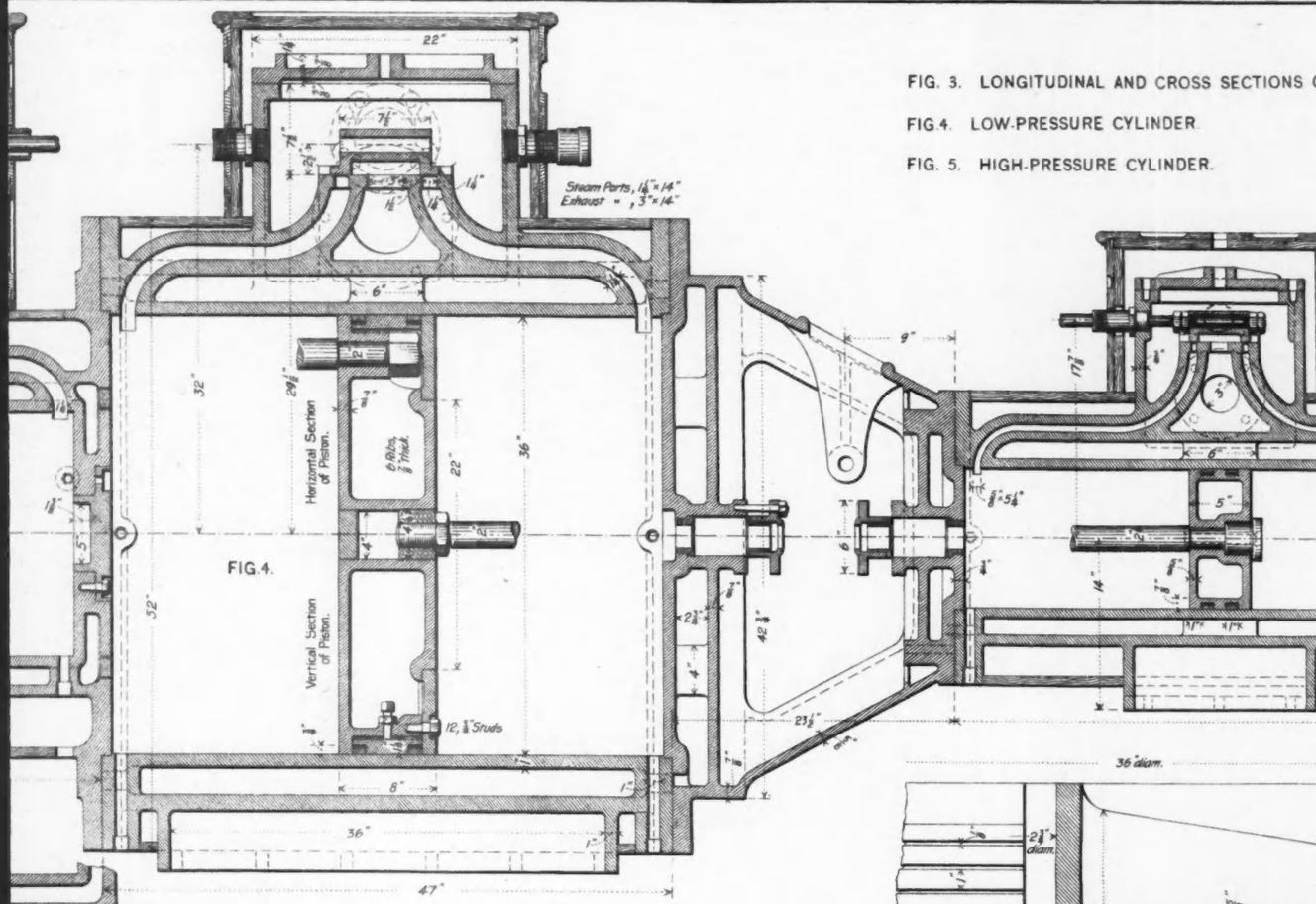


FIG.4.

FIG. 7. PUMP PISTON.

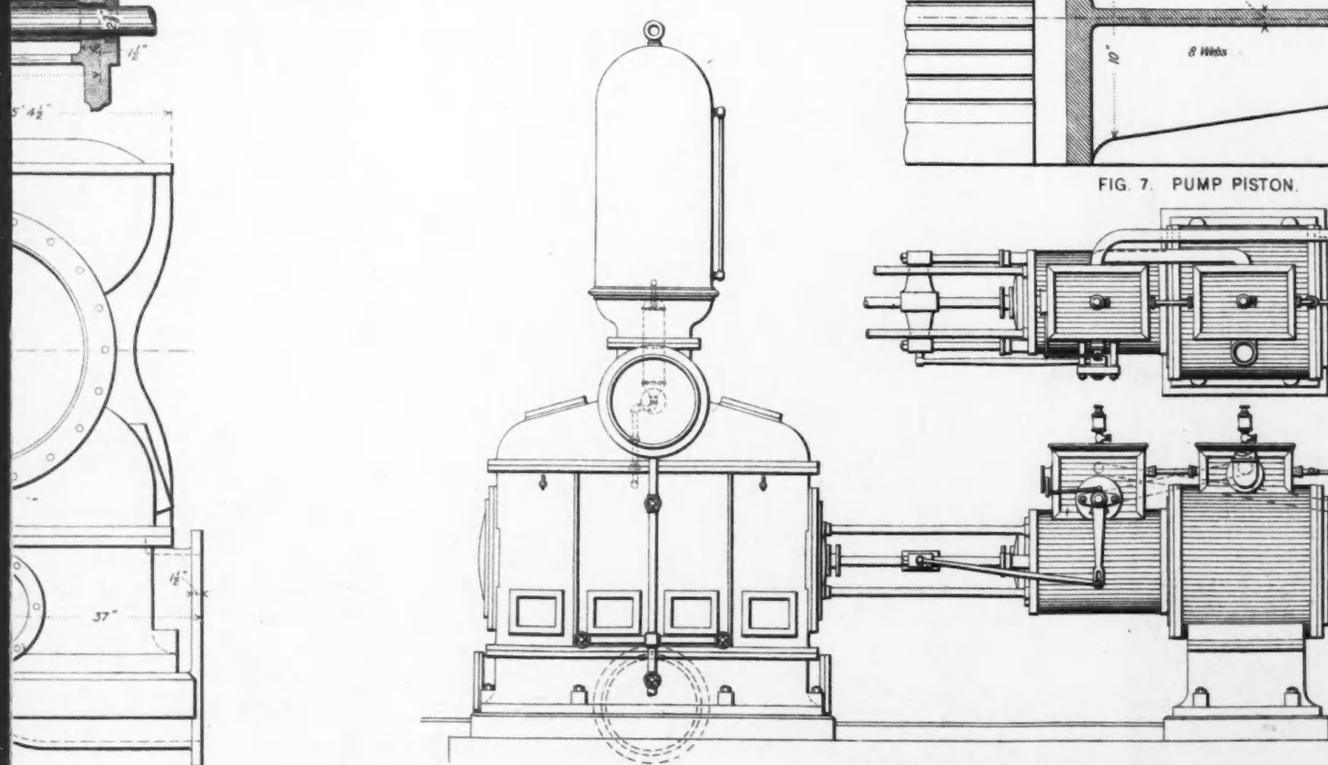


FIG. 1. SIDE ELEVATION AND PART PLAN.

NG ENGINE FOR MILLBURN STATION, BROOKLYN WATER-WORKS EXTENSION.

ned and Built by M. T. Davidson, Brooklyn, N. Y.

CTIONS OF INTERMEDIATE CYLINDER.

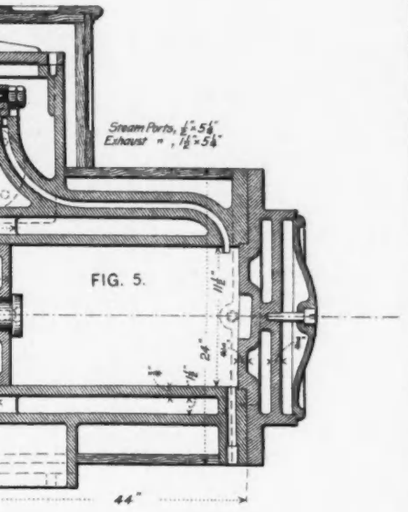
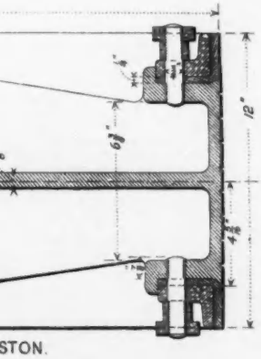


FIG. 5.



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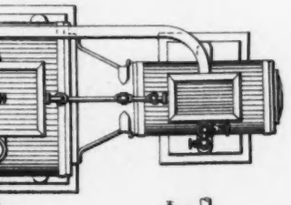
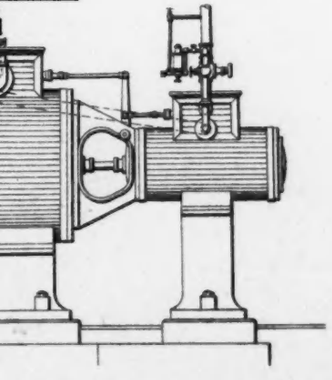




CHAS. HART & SONS, LITH., 56 VESEY ST., N. Y.

tum at present is to dispense with the link slot and pin hole in the knuckle, where nearly all the knuckle failures occur. The "Perfection" coupler, which has been in use for some months on the Louisville & Nashville R. R., secures this manifest advantage at the present time. The knuckle is made solid, and is simply turned to one side when a coupling is to be made with a link and pin drawhead. Another coupler in which the same thing is done has been recently patented. It really seems as if there were a chance for an improvement to be made in coupler construction in this direction, which it will be noticed does not in any way conflict with the M. C. B. lines or with use with other M. C. B. couplers. It may be, however, that this change would necessitate undesirable complications and changes which would weaken other parts of the coupler; and it is to be remembered that many railway officers are strongly impressed with the need of uniformity in couplers. Any radical change in design is likely to meet with small favor from these men.

Doctors differ materially in regard to the population of New York City, and yet not so radically as the face of the returns would indicate. It is to be remembered that it is 20 months since the U. S. census was taken, and some 16 months (if we remember correctly) since the police census was taken. It is a reasonable estimate, judging by past rates of growth, that the natural growth of the city has been 6% and 5% respectively in those periods, and allowing for this growth the comparative present population would stand as follows:

	Population returned.	To which add.	Population for Feb. 92.
U. S. Census, June, 1890..	1,515,510	6% 90,931	1,606,441
Police Census, Oct. 1890 .	1,710,715	5% 85,536	1,796. 51
State Census, Feb. 1892..	1,800,891	.....	1,800,891

It will be seen from the last or equated column that the police and State censuses really compare pretty well, differing only 4,640 from each other, each being about 192,000 higher than the U. S. census. The annual summer exodus which is already under way when the United States census is taken (June 1-15) will account for between 50,000 and 100,000 of this difference, and the "shifting but persistent" crowd of transients in New York, at hotels and boarding houses and in private families, which is now estimated at over 150,000, will more than account for the rest. As respects the summer exodus, the error is unavoidable under the present law, which requires the census to be taken in June, but it is none the less unfair to this and other cities, and the agitation which the last census has provoked will, we trust, lead to a change of date to April or May instead of June. As respects the floating or transient population, there are two theories of enumeration; one, which prevails in Great Britain and may be called the "photographic" one, is to enumerate the whole population according to the place where they slept on some one night, regardless of permanent residence. The other, which seems more in consonance with our system of representative government, and which is here the law, is to enumerate every individual according to his permanent abiding place. We fear a good many transients were counted in the police and State census who were not legally residents of New York, and that the true legal population lies between the diverse returns and is now about 1,700,000; but it is obvious that in fact, if not in law, metropolitan cities which have hundreds of hotels always well filled are made so much larger by that fact; and from this point of view we feel no doubt that the real population of New York is at least 1,800,000, to which is to be added 650,000 for Brooklyn and at least 300,000 for Jersey City, Hoboken, Staten Island, etc., making a true metropolitan population of over 3,000,000, against 4,500,000 to 5,000,000 in the corresponding part of London, neglecting in both cases the outer ring of suburbs.

WESTINGHOUSE AND OTHER AIR BRAKES ON THE VANDERBILT RAILWAYS.

The necessity for railway mechanical officers posting themselves thoroughly on the details of automatic air-brakes and their mode of action is becoming more and more apparent; and it is not only the officers of railways which propose to try some other brake than the Westinghouse who are interested but the officers of all railways interchanging cars with other roads. The fitting of a thousand freight cars with a new kind of brake is a matter which interests every railway company over whose lines these cars may run, much more than it does the single company owning the cars.

What the railways of the country wish to know concerning any new brake offered as interchangeable with the Westinghouse, is whether it is practically identical in its action with that brake; whether in service applications it will give practically the same braking force with a given reduction of pressure as is secured by a Westinghouse brake on the next car whether the quick action portion of the valve will operate when the Westinghouse operates and never otherwise, and whether the brake will release by the same process and with practically the same ease and certainty as the Westinghouse.

There are, of course, other details, such as its ability to work with the Westinghouse engineer's valve, general character of workmanship, etc.; but those named above are the most important. It is almost needless to say that the Westinghouse brake is not set up as a standard by railway officers because of partiality for the Westinghouse Co. About 20% of the freight cars of the country are now equipped with Westinghouse brakes, and any new kind of brake, mechanical, electrical or pneumatic, not interchangeable with the brakes now in service, would have to show almost inconceivably great practical advantages in order to warrant its adoption as the standard in place of the Westinghouse.

This fact is fully recognized by makers of all the brakes which are now offered to railway men. They are all claimed to be interchangeable with the Westinghouse and to operate in harmony with it. To what extent these claims are true, it will probably be left for actual service to finally settle. Rack tests and runs with test trains fitted with new apparatus throughout are valuable so far as they go; but they still leave unanswered the question how the apparatus will work when subjected to the vicissitudes of service. Total neglect, too copious oiling, air pressure too high or too low, improper handling by the engineer—these are a few of the things which affect the action of the brakes in service, and cause trouble even with the Westinghouse triple-valves. Whether the newer candidates for favor will be more or less susceptible to these influences is the question to be settled.

The mechanical officers of the Vanderbilt lines have been considering these matters, and as a result, we understand, an order has been recently issued directing car inspectors to cut out the brake on receiving cars from foreign roads fitted with other air brakes than the Westinghouse. To facilitate the inspectors' work, the representatives of the Vanderbilt lines are likely to move in the next Master Car Builders' Convention for a rule requiring the name of the brake to be stenciled on each air-brake car.

At first glance this order of the Vanderbilt officials seems a mistaken one. Why not let the brake do what work it will, be it more or less? It would, in any event, probably do more braking than would be done on the car by hand. On the other hand, it is said that some of the new triple-valves on the market are not identical with the Westinghouse in securing emergency application; some are likely to give the quick action when a service application is intended; others fail in the opposite direction. Evidently brakes which are defective in either of these ways would be most undesirable in a train of Westinghouse cars. The engineer attempting to check speed by a service application at the head of a long grade might find his train coming to a sudden halt, for the opening of the quick action valve on a single car is sufficient to apply the quick action on the whole train. Or, if we suppose a brake in which the quick action is less easily secured than with the Westinghouse, an engineer might produce some astonishing thumps in his rear cars in making an emergency stop if a few cars in the middle of the train contented themselves with a service application.

It is troubles like these which the Vanderbilt roads propose to avoid by cutting out brakes other than the Westinghouse when received from foreign roads. But unless their order is modified somewhat, it will open the door for other dangers by no means insignificant. As we pointed out last week, the number of cut out cars which the quick-action can jump was found in the Lehigh Valley tests to be only 3 with the New York triple-valve and 4 with the Westinghouse. It is claimed, however, that the Westinghouse triple valves will secure quick action past 6 cut-out cars, when the train-pipe pressure is 70 lbs. Making allowance for sluggish action of valves obstructed by dirt and gum, it is evident that a few cut-out cars bunched together at the middle of a train are likely to stop the quick action and give only a service application on the rear, when an emergency application has been made on the front.

The shocks which would follow such an application might be most serious. Such a thing is the more likely to happen as some of the new styles of brakes have been applied to cars owned by private companies, such as stock cars, and a number of them are quite likely to be run together in service and be switched together in making up trains. It is true that the emergency application ought not to be made without good reason; but on a crowded road it will be made quite often, and the danger to cars and freight from such a partial application on a train as we have just outlined is considerable. If rules are to be put in force that cars with other brakes than the Westinghouse are to be cut out, trainmen should be instructed to avoid the bunching of more than two or three cut-out cars together, and where possible they should be put at the rear of the train, the train pipe being left connected to secure an automatic stop in case of a break-in-two. Such a rule, in fact, might well be made general in its application, and be adopted as part of the standard code for trainmen's instruction.

It is of course true that the order put in force on the Vanderbilt roads must be regarded as a temporary expedient, adopted while the practical interchangeability of the newer brakes with the Westinghouse brake remains, in some degree at least, a matter of doubt. If it shall be proved of any brake that it is actually and practically as good as the Westinghouse in every day service, the Vanderbilt companies will certainly not lose the use of such brakes in hauling cars equipped with them over their roads. If, on the other hand, any brake is found to be so subject to the defects we have outlined as to interfere with the safety and efficiency of the Westinghouse apparatus, then its disappearance will be a matter of no long time and the necessity for the order above noted will disappear.

THE MASSACHUSETTS RAILROAD COMMISSION REPORT.

The annual report of the Massachusetts Board of Railroad Commissioners is always an instructive and interesting document. In certain things, as notably in its mode of presenting statistics of casualties to persons, it is unnecessarily defective, as we have lately had occasion to show; but on the whole, of all our state railway reports it is the one most worthy of careful perusal and review. The report for the year ending June 30, 1891, presented to the legislature this week, is no exception to this rule. On the contrary, it is one of the most complete and valuable reports in the whole series.

The most notable single feature of the report is the detailed and exhaustive investigation of the Hungarian and Austrian zone systems of passenger tariffs, with the resulting conclusion that the system is not applicable to our conditions, and that its main benefit abroad has come from the lowering of rates, not from the changed mode of assessing them. This part of the report, as also that on the abolition of grade crossings, we abstract quite fully in another column, and need not further review.

The report opens with a discussion of the desirability of "harmony in legislation," which, however, has been already secured more fully than is generally appreciated. The commission recommends a compilation according to cognate features of the general railroad laws of each of the New England states and New York state.

Then follows a most satisfactory and gratifying review of the progress of steam heating, the pith of which may be said to lie in the following table, showing a progress which in the more creditable, because it has been achieved without legislative compulsion. The table is not quite complete, inasmuch as it covers only 3,114 out of some 3,140 cars in the state, and, therefore is not totaled, but we add the totals, as constituting a practically complete return for the state of all passenger cars heated by steam in each of the five years since the movement begun:

Companies.	No. cars heated by steam from locomotive. 1887.	1888.	1889.	1890.	1891.	Not so heated 1890.	1891.
Boston & Albany..	106	226	243	267	335	56	10
Boston & Maine...	0	11	232	317	422	507	433
Fitchburg.....	11	73	(247)	247	242	1	0
New York & N. E.	16	74	158	178	223	78	33
Old Colony.....	67	150	152	168	269	331	251
Connecticut River.	24	34	50	59	60	0	0
Housatonic.....	0	0	0	0	22	93	71
New London No'rn	0	5	16	19	17	6	5
N. Y., New Haven & Hartford.....	0	0	0	0	531	(551)	20
N. Y., Prov. & Boston (formerly Prov.& W're'st'r)	17	23	40	65	141	0	0
Boston, Rev. Bch. & Lynn.....	(25)	(25)	(25)	27	29	0	0
Nashua, Acton & B.	0	0	0	0	0	2	0
Totals	266	621	1,163	1,347	2,291	1,625	823

Note.—The numbers in parentheses may not be quite precise. The original table simply says "all."—Ed.

The total number of cars fitted for heating by steam from the locomotive is now 2,291, or 73% of the whole number of cars used in the winter season. The increase over last year is 944 or 30% of the whole.

Even this showing for 1891, good as it is, does not fully represent the status during the present winter. The Housatonic road, for instance, though it reports only 24% of its cars equipped for steam heat, will heat 50% of its trains this winter by steam heat. Altogether, it may be said that all roads in the state but three are fully equipped for steam heating, and that these three are more than half equipped, and are likely to be fully so next winter.

The history of railroading affords no parallel to so swift and radical a reform as this; for the continent generally has been progressing almost as fast as Massachusetts. The commission gives a summary of the official action in Massachusetts, which we can abstract more intelligently by combining with it the unofficial but really more important facts, and thus show a full history of the reform to date.

Prior to Jan. 1, 1887, steam heating was used on only a few roads (the New York elevated lines being by far the most important and the only ones heating all cars by steam) and chiefly in a tentative way. Fortunately, however (for it was indeed fortunate and in the end more merciful) that winter was characterized by a succession of railway horrors of the first class, in which fire caused most of the loss of life, and by which railway officials and the public generally were profoundly moved. The series began Oct. 28, 1886, with the Rio derailment (C., M. & St. P.) by which 17 lives were lost, mostly by fire. Two months later (Jan. 4, 1887) it was followed by the Republic collision (B. & O.) with 13 burned alive or killed and 5 injured, and by the Mitteneague derailment (Boston & Albany) with 2 killed and 20 injured. Only 10 days later came the frightful Woodstock bridge derailment (Cent. Vt.) in which 32 were (nearly all) burned alive and 37 or more injured, and this was followed, only two months later, March 14, 1887, by the Bussey bridge disaster (24 killed and 115 injured), in which terrific loss of life by fire was threatened among the 200 or more exposed passengers of the train, and was only escaped by the presence of mind of one man and the arrival of a steam fire engine. As if this were not enough, a few months later (Aug. 10, 1887) came the still worse Chatsworth disaster, in which indeed car stoves did not figure, since it was in summer, but in which fire did figure, and in which, as it was, 77 lives were lost and 130 injured.

No such series of fire disasters in quick succession has ever occurred before or since. It really settled the steam heating question out of hand; and yet, when the Woodstock disaster occurred this was the only technical journal which ventured to take any decided stand on the matter, such as we took in the following extract from our comments on that disaster:

There can now be no doubt that the locomotive can abundantly well spare the necessary steam to heat the cars, with some possible inconvenience in the severest weather with heavy trains; and there seems as little doubt that the mechanical difficulties of distributing the steam have been fairly well overcome by at least three systems which are in quite extensive use, the Martin, Gould and Emerson. While no one of the three systems can be said to have had such extensive test under all conditions as to make the demanded legislation for the peremptory banishment of fire on passenger cars expedient or justifiable; the first two at least have advanced so far toward perfection as to make it quite certain that if railways were effectually forbidden to use fire in cars after a period of three or five years, no engineering difficulties would impede the heating of cars by steam at the end of that period, in a satisfactory and economical way. Much more than this is claimed, and not without apparent reason, but the above is all that can with certainty be said.—[Eng. News, Feb. 12, 1887.]

This opinion, as our old subscribers will remember, we followed up in our next and many following, issues by more detailed expressions of similar views, hardly a line of which, as we read them over, we could now wish had said anything less or different. Our contemporary the "Sanitary Engineer" (as it then was) followed us promptly in this position. All others, so far as we now recall, contented themselves by expressing vague hopes and doubts, or (some of the most prominent of them) throwing cold water on steam heating as a chimera. Toward the end of 1887, however, all men began to see how the wind was blowing, and since then the only question has been one of time and of detail.

We are compelled for lack of space to postpone the completion of our review of steam heating progress, and of the remainder of the report, until our next issue.

LETTERS TO THE EDITOR.

THE GREAT NORTHERN RAILWAY.—CORRECTION.

Sir: In your issue of Feb. 13, referring to the rail section of the Great Northern Ry., you mentioned meas the Chief Engineer of the Great Northern Ry. Mr. N. D. Miller, of St. Paul, is Chief Engineer of the Great Northern Ry. My position is as signed. Yours truly,

E. H. BECKLER,
Chief Eng'r Pac. Ext'n St. P., M. & M. Ry.

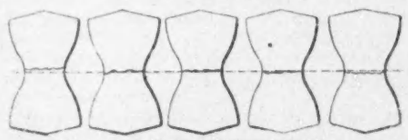
[The error originated in the fact that the letter sheet was headed "Great Northern Railway Line, Engineering Department, Helena, Montana," and the subdivision of control was overlooked.—Ed.]

BREAKING CEMENT BRIQUETTES AT THE CENTER.

Sir: In order to prove the claims that I make for the W. R. C. grip for cement testing, I had a set of ten briquettes made at the testing laboratory of the Lawrence Cement Co., of this city. The cement was carefully sifted through a 50-mesh sieve. Five of these briquettes were tested with the ordinary grip, and five with the W. R. C. grip, with results indicated on the enclosed blue print, which I think clearly indicates that the imperfect fractures are due to the use of the old style grip, and the perfect fractures to a grip with protected edges.

The breaking of the briquettes was made under my supervision, and I know that every care was taken to set the briquettes so that the pull would be perfectly straight. I attribute the central fractures with the W. R. C. grip

Broken with Standard Grip.



Broken with W. R. C. Rubber-Faced Grip.

Comparative Results of Breaking Cement Briquettes With Different Grips.

to the fact that the yielding of the rubber allowed the briquettes to center themselves perfectly, which in the case of those tested with the old grip, was not possibly closer than they could be placed by the eye.

In other words, I claim that all that is necessary to obtain a fracture at or near the center of the "shank," is a perfectly straight pull, which can only be accomplished by the use of a grip with a yielding surface at the points of contact of the grip with the briquette, which I believe, is accomplished with the W. R. C. grip.

Very respectfully, Wm. R. Cock.

New York, Feb. 15, 1892.

[The W. R. C. grip has a rubber cushion between the contact surfaces of the grip and the briquette. It was described and illustrated in our issue of Dec. 20, 1890.—Ed.]

TOWING TRIANGLES IN WATER.

Sir: I noticed in a late number of Engineering News a statement to the effect that "a triangle may be towed more easily through the water side first than angle first." Is this so? If so, will you kindly explain why it is so through your columns. Surely the less resistance offered in front by towing angle first is of more advantage than the closing up of the water behind in the other case.

Detroit, Mich., Feb. 16, 1892. R. E.

[The statement was made in a contributed article, and we assume no responsibility for it. Experiment alone can decide the fact, and failing records of experiment, abstract reasoning as to why it should or should not be so is of little worth.—Ed.]

"A PAVING BRICK STRONGER THAN GRANITE."

Sir: The communication in Engineering News of Feb. 6, headed "A Paving Brick Stronger than Granite," to my mind should call forth a protest against the too frequent practice of drawing conclusions from single and irregular tests.

The record given of these four tests does not warrant any comparison of the relative strength of the three materials. The specimens of sandstone and Sioux Falls granite were much less favorable for withstanding high pressures than the specimens of brick, as shown by the area of surface pressed and the cubical dimensions of the specimens. The comparison in question, however, overlooks this discrepancy.

It appears to me like snap judgment to draw conclusions as to the real or relative strength of materials based upon but one or two tests, especially when the materials are stone or brick, and the test specimens largely variable in size and form. To show that single or scanty tests may be largely misleading, note that of the two specimens of brick, the larger and more favorably shaped specimen failed at about two-thirds of the strength of the smaller. Yours truly,

St. Paul, Minn., Feb. 19, 1892. Chas. F. Loweth.

[Whatever justice our correspondent's complaint has is against us, and not against the author of the letter, in which facts only were given without comment or claim. Our own fault, if any, lay merely in stating that "a paving brick" had proved to be stronger than granite, which was the fact. As one swallow does not make a summer, so a claim for "a paving brick" does not indicate that the same claim is made for all paving bricks of its class.—Ed.]

THE PAYMENT FOR AREA COVERED BY RAILS IN STREET PAVEMENT.

Sir: In the city of Albany the matter of paying the contractor for the area covered by the rails of the street railway was first agitated in 1886; the contract for paving Washington Ave. with granite blocks left the matter of rail area an open question; the contractor was, therefore, paid for the rail area in this case, and the railway company paid their assessment with the understanding that a legislative enactment should fix their liabilities for future assessments. The act referred to was passed in 1888, and provides that the street railway companies "shall be assessed for the work, labor and services performed, and all materials furnished for any of the works and improvements done between the rails of each track and for no more."

In a 36-ft. carriageway the rail area for a double track railway is about 4.5% of the entire amount. It is manifestly unjust to pay the contractor for this, if the abutting property owners will have to pay the assessment; hence it has been usual since 1886 to expressly provide in the specifications that the area of rails should be deducted and not paid for as pavement laid. The matter is too important to be overlooked or left obscure in the specifications; local conditions should regulate the payment or non-payment for this area; when these conditions are as stated here it seems best to specify as stated above.

Very truly yours,
Horace Andrews, City Engineer.

Albany, N. Y., March 4.

EFFECT OF HIGH SPEEDS ON VIRTUAL GRADIENTS.

Sir: In your article on the "Proposed Chicago & St. Louis Electric Railway," published in your issue of Feb. 20, I notice a sentence as follows: "At the extremely high speeds proposed, the grades become comparatively unimportant with any motor."

Will you kindly explain why excessive speed eliminates the importance of grades on this line, as I assume the statement is not meant to apply generally. Yours truly,

H. L. Van Zile.

Albany, N. Y., Feb. 20, 1892.

[The statement was intended to apply generally, and in the broadest way. As we know there are many other engineers, like our correspondent, who do not properly appreciate the vast distinction between actual and virtual gradients, we will briefly explain, that a body moving through space in any direction with a given velocity, has stored in it a certain invariable and readily computable amount of energy, which is just sufficient to lift it vertically against the resistance of gravity, through such a height as it would have to fall from vertically in order to acquire that velocity. For a speed of 10 miles per hour this height (now generally called the "velocity head") is only 3.55 f for a speed of 30

miles per hour it is 31.95 ft.; for a speed of 60 miles high it is 127.80 ft., and for a speed of 100 miles per hour it rises to 355.00 ft. Consequently, if we have a train running on a level, propelled by such a power that it is kept moving at 10 miles per hour without gaining or losing velocity, any rise or "hummock" in the grade line exceeding 3.55 ft. in height will bring it to a stop; if the speed is 30 miles per hour the hummock must be 31.95 ft. high to have the same effect; if the speed be 60 miles per hour, it must be 127.80 ft. per hour to have the same effect, and if 100 miles per hour it must be 355 ft. high to have the same effect, or higher than any hill to be found in Illinois between Chicago and St. Louis. In every case these retarding effects are wholly independent of the rate of the grade by which the hill is climbed; and with train speeds of 100 miles per hour the only effect of climbing a hill 100 ft. high on any grade is to reduce the speed at the top of the hill to about 86 miles per hour, the original speed being recovered by the descent on the other side. If the grade of ascent and descent were each two miles long, the main speed over that four miles would be

$$\frac{100 + 86}{2} = 93 \text{ miles per hour,}$$

requiring 2 min. 35 sec. for the passage, against 2 min. 24 sec. for going over the same distance on a dead level at 100 miles per hour. Hence the only loss from interjecting a 100-ft. hill with 50 ft. per mile grades in a dead level is (with train speeds of 100 miles per hour) 11 seconds of time, this loss being only half as much, moreover, if the approach grades are twice as steep and half as long. No extra motive power whatever is required for making the climb.

All this is fully explained in the chapter on the Rise and Fall in The "Economic Theory of the Location of Railways," but as it is not explained in any other engineering text book it is still little understood.—Ed.]

A SUCCESSFUL EXPERIMENT IN SHORE PROTECTION.

Sir: A plan somewhat similar to the "New Method of Shore Protection" described in Engineering News of Feb. 6, was tried by the writer in the fall of 1885 on the Warrior River, Ala. As the results were satisfactory and obtained at reasonable cost, a description may be of interest and possible value.

It was thought advisable to revet a caving bank some 30 to 35 ft. high and 3,000 ft. long, curving with a radius of 1,200 ft. The bank was of a stiff clay and sand mixture, that yielded in large flakes to the undermining action of a rising river. In high water the bank was flooded 10 to 15 ft.

As the bank had caved quite irregularly, leaving a very ragged edge, it was not easily practicable to give a uniform slope, and that obtained was from 1½ to 1 to 2 to 1. Upon this loose brush was laid, like shingling or thatch, with the leaves and twigs next the earth, and the butts of one course overlapping the twigs of the last. The thatching was commenced at the top of the bank and laid in courses, one foot thick. As rock was not obtainable, the courses, as fast as laid, were fastened down by wires stretched horizontally, secured to stout stakes driven by hand mauls 4 ft. into the ground and spaced 6 ft. apart. After standing some days the stakes were again driven as far as possible in order to press the brush firmly against the slope.

The theory on which the plan was based, was that the rough surface presented by the straggling butts of the brush would so check the current passing through them that the sediment (with which the river, in flood time, is highly charged) would be deposited and the brush would become thoroughly silted up. It was expected that, from the rich soil thus placed upon the slope, a self-sown growth would spring up that in a few years would afford a live revetment sufficient to protect the bank after the wired brush should have decayed. This expectation was fully realized. In two years a growth had become well started, and the slope is now covered with elm and cottonwood saplings 10 to 15 ft. high.

The work was done entirely by hand labor with a force that, owing to sickness, did not average more than 15 working men. Of course, the cost of superintendence formed a large percentage of the expense, which, however, did not quite reach 17 cts. per sq. yd. Nothing was paid, however, for brush.

With a suitable force and equipment, the writer believes that in many places the method described will be found a cheap and efficient plan for protecting river banks. It will probably be found necessary, however, to make slight repairs for a year or two, or until the young growth shall have become well established. On rivers that run heavy masses of ice the plan would probably not be available.

H. Harding, C. E.

Black Warrior Imp't, Engineer's Office,
Tuscaloosa, Ala., Feb. 11, 1892.

[While this experiment was certainly one of great interest and "success crowns the work," it strikes us that slightly easier slopes than those stated would in most cases add greatly to the chances of permanent success.—Ed].

A BRICK-MEASURING DIAGRAM.

Sir: The publication, in Engineering News of Jan. 9, of the size and cost of paving bricks, leads me to send you the enclosed graphical table which is useful in arriving at a quick approximation to the number per sq. yd. of bricks or stone blocks. I take two examples from the list given by you.

Bricks 2 $\frac{7}{16}$ in. by 8¾ in. costing $18.58 per M., if laid with ⅛ in. joints are found from an inspection of the table to lay 57 to the sq. yd., costing $1.06; while bricks 2¼ in. by 7 $\frac{7}{16}$ in., also laid with ⅛ in. joints, require no less a number than 71, which at $14.00 per M. will cost $0.99 $\frac{1}{16}$.

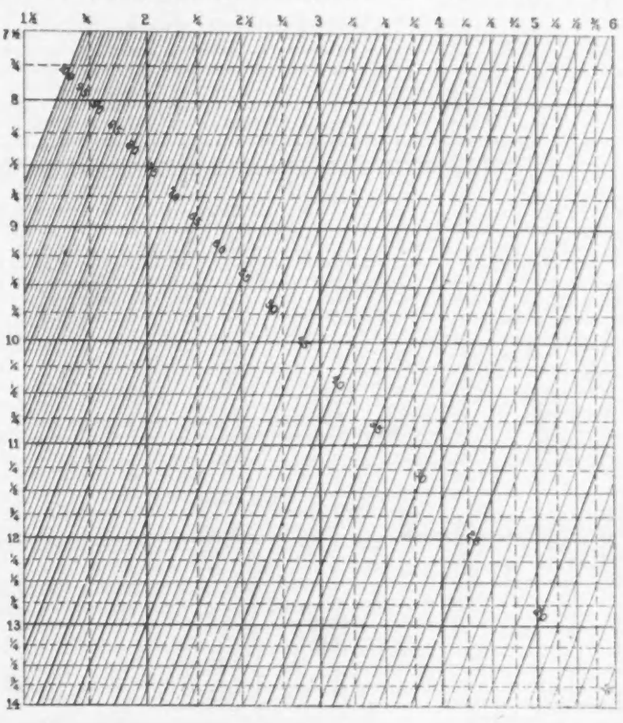


DIAGRAM FOR CALCULATING NUMBER OF BRICKS PER SQUARE YARD.

The table is an interesting example of the application of logarithms, which when used as arguments in plotting the multiplier and multiplicand will give the products in straight parallel lines; a few of which only were located the remainder being spaced off from the divisions of a slide rule.

Very truly yours,

Horace Andrews.

Albany, N. Y., Jan. 25, 1892.

STORAGE CAPACITY OF THE NEW WATER SUPPLY FOR NEWARK, N. J.

Sir: The East Jersey Water Co. has contracted to furnish the City of Newark, N. J., a water supply system insuring the delivery of 50,000,000 gallons of water daily. Although only 27,500,000 gallons are to be furnished at first, the capacity of the supply, when turned over to the city, must equal the maximum standard above given. The works were to be ready for operation May 1, 1892. Mr. Alphonse Fteley, consulting engineer, has reported to the Newark authorities (see Eng. News, Feb. 27, 1892) that the storage capacity provided by the East Jersey Water Co. in the Pequannock watershed does not insure a delivery of 50,000,000 gallons of water daily in seasons of drought, but only 35,000,000 gallons.

The total storage capacity at present provided is as follows:

	Gallons.
Oak Ridge reservoir	2,550,952,000
Clinton reservoir	3,534,830,000
Macopin intake reservoir	32,089 000
Total	6,117,851,000

The Pequannock drainage area, from which the Newark supply is to be drawn, includes 65 sq. miles. It is adjacent to the Lake Hopatcong drainage area, and similar in its essential features as a source of water supply. The record of the rainfall and flow of the latter area, kept by the Morris Canal & Banking Co., and quoted by Prof. Geo. H. Cook, for many years State Geologist of New Jersey, and by Messrs. J. J. R. Croes and Geo. W. Howell, in their Report on Additional Water Supply made to the Newark Aqueduct Board in 1879, gives the mean annual rainfall as 42.55 ins. for the 24 years from 1866 to 1889, inclusive. The record for the 3 driest years, and the per cent. collectable, the latter estimated by Messrs. Croes and Howell, is a sfollows:

Year.	Rainfall, ins.	Per cent. collectable, ins.
1862	32.19	48.6
1864	31.50	66.2
1866	30.06	49.3

If the one driest year be allowed to fix the standard for dry season flow, and Croes and Howell's estimate of per cent. collectable be taken, we should have as the standard of dry season flow 49.3% of 30.06 ins., or 14.81 ins.

This accords substantially with Mr. C. C. Vermeule's estimate of collectable per cent. of rainfall in the Archæan Highlands, given in the last State Geological Report of New Jersey. He says: "Our researches indicate that we cannot depend upon collecting more than 14 ins. of the rainfall upon our water, sheds."

One inch per square mile of water is 17,424,000 gallons One inch on the 65 sq. miles of the Pequannock watershed is 1,132,560,000 gallons; 14.81 ins. is 16,773,213,600 gallons. If Newark is to receive 50,000,000 gallons per day her demand is 18,250,000,000 gallons per year. The dry year flow according to the minimum Hopatcong standard, is therefore 1,476,786,400 gallons short of the annual contract demand, or a little over 4,000,000 gallons daily.

This is an average daily shortage, in the flow in driest years, of over one-twelfth of the required daily amount, and indicates the amount requiring to be provided for by additional storage.

The standard of storage capacity given by J. T. Fanning in his work on "Water Supply," for utilizing "the greatest possible portion of the flow" is 20 to 25% of the mean annual rainfall. Using Fanning's lowest figure we find 20% of the mean annual rainfall, 42.55 ins., to be 8.51 ins., which, on the 65 square miles of the Pequannock watershed would be 9,638,085,600 gallons.

According to Fanning's lowest standard, then, and using round numbers, the Pequannock storage capacity, to furnish 50,000,000 gallons per day in driest years, should be at least 9,500,000,000 gallons. This estimate closely corresponds with the standard given by Frederick P. Stearns, Engineer of the Massachusetts State Board of Health, and long associated with Mr. Fteley in connection with the Boston water supply. In his report for 1890 he furnishes a table showing the amount of storage required to make available daily volumes of water for consumption. (See Eng. News for Nov. 7, 1891.) In that table he estimates that when the daily draft is at the rate of 800,000 gallons per square mile of drainage area (which would be a ratio of 52,000,000 gallons per day from the Pequannock area), the storage required to prevent a deficiency in the season of greatest drought would be 214,000,000 gallons per square mile. This would be a total storage capacity for 65 square miles of 13,910,000,000 gallons.

As the particular figures he uses concerning daily draft in this calculation are in excess of that required from the Pequannock area, making allowance for the excess in draft and required storage in the particular case he gives, yet preserving his ratio between draft and storage, it appears that Stearns' standard closely conforms to that of Fanning.

And Stearns' estimate is the more important because of his long experience with the Sudbury River drainage area, which in extent and natural features has many points of similarity to the Pequannock area.

Mr Fteley's opinion, therefore, that the present storage provision in the Pequannock system, being only for 6,100,000,000 gallons, cannot be relied on in driest years to furnish more than $^{7}/_{16}$ of the daily maximum demand of the Newark contract, would seem to be justified by the highest expert standards.

The same conclusions were reached by J. J. R. Croes, C. E., and presented to the Newark Aqueduct Board at their meeting, held Jan. 15, 1889, for discussion of the new water supply. Mr. Croes wrote:

It is proper to state in the first place that in 1878, in connection with Mr. George W. Howell, C. E., I made, on

behalf of the city of Newark, a thorough examination of the watershed of the Pequannock River, and its capacity and availability as a source of supply for the city. I have further examined with care the reports of the Commissioners of State Water Supply of New Jersey, made in 1884. I have further examined the watershed of the Pequannock River in 1887 on behalf of the Lehigh Valley R. R. Co., while engaged in determining for them the amount of water necessary for operating the Morris Canal.

The proposition of the Pequannock Water Co. [a company at that time seeking to make a contract with Newark], as I understand it, is to divert the Pequannock River at a point between Smith's Mills and Charlottesburgh [near the present intake], and to furnish from that point 50,000,000 gallons per day for the city.

The essential part of the proposition is the guarantee by the Pequannock Water Co. that the watershed above the point of diversion can be depended upon to furnish 50,000,000 gallons a day continuously. It is my opinion that, all the circumstances of the case being taken into consideration, this quantity of water cannot be guaranteed to be furnished from the watershed of the Pequannock River above Smith's Mills.

I think it would be practicable to furnish 50,000,000 gallons a day from a watershed of this area, provided that ample capacity for storage of water could be had at the proper point within the watershed. The quantity of water which can be depended upon from an area of 89 sq. miles, which is as nearly as can be ascertained the drainage area above the proposed point of diversion (it has since been found to be only 64.5 sq. miles), does not exceed 600,000 gallons per day per square mile, and to insure the delivery of this amount of water in dry seasons it is necessary to have storage reservoirs of large capacity, and to have these reservoirs so situated on the stream that water from the entire watershed can be stored. This makes it necessary that a large storage reservoir should be built on the main stream at or near the point of diversion. No site for such a reservoir exists on the line of the Pequannock River above Smith's Mills.

There seems to be no question raised by Mr. Fteley as to the capability of the Pequannock area, with sufficient reservoir capacity, to yield the necessary amount of water demanded in the Newark contract. The present storage capacity is also ample to meet the present needs of Newark, which now requires less than 20,000,000 gallons per day. But inasmuch as the East Jersey Water Co. has contracted to provide for 50,000,000 gallons per day, the city authorities are disposed to hold the company to the contract, and probably the company will have to furnish storage works for several billions of gallons more than they have now provided before the city will accept the works.

But theories are sometimes badly overturned by facts. Whatever the estimated deficiencies in the artificial storage capacity of the Pequannock system may be, Mr. Herschel finds that Lake Macopin alone has a natural flow almost adequate to the demands of Newark. And further, if Newark should deem the present provision inadequate under the contract, still the contract allows the water company time to meet any deficiency, if actual trial proves its existence.

Newark, N. J., Feb. 26, 1891. FRANKLIN.

[Mr. Fteley's report on the new water supply system for Newark was published in our issue of Feb. 27, 1892. It was not accompanied by the detailed data upon which his conclusions as to the supply capacity of the new system were based, but these may be given in the final report, not yet prepared. We are pleased to give space to the above communication, thinking the figures, aside from their direct present bearing upon the Newark supply, will be of interest to hydraulic engineers.—Ed.]

A NEW SYSTEM OF SUSPENSION BRIDGES.

Sir: The accompanying drawing illustrates a system of suspension bridges, which, according to my belief, has many advantages over others and seems to be the most convenient and economical for large spans.

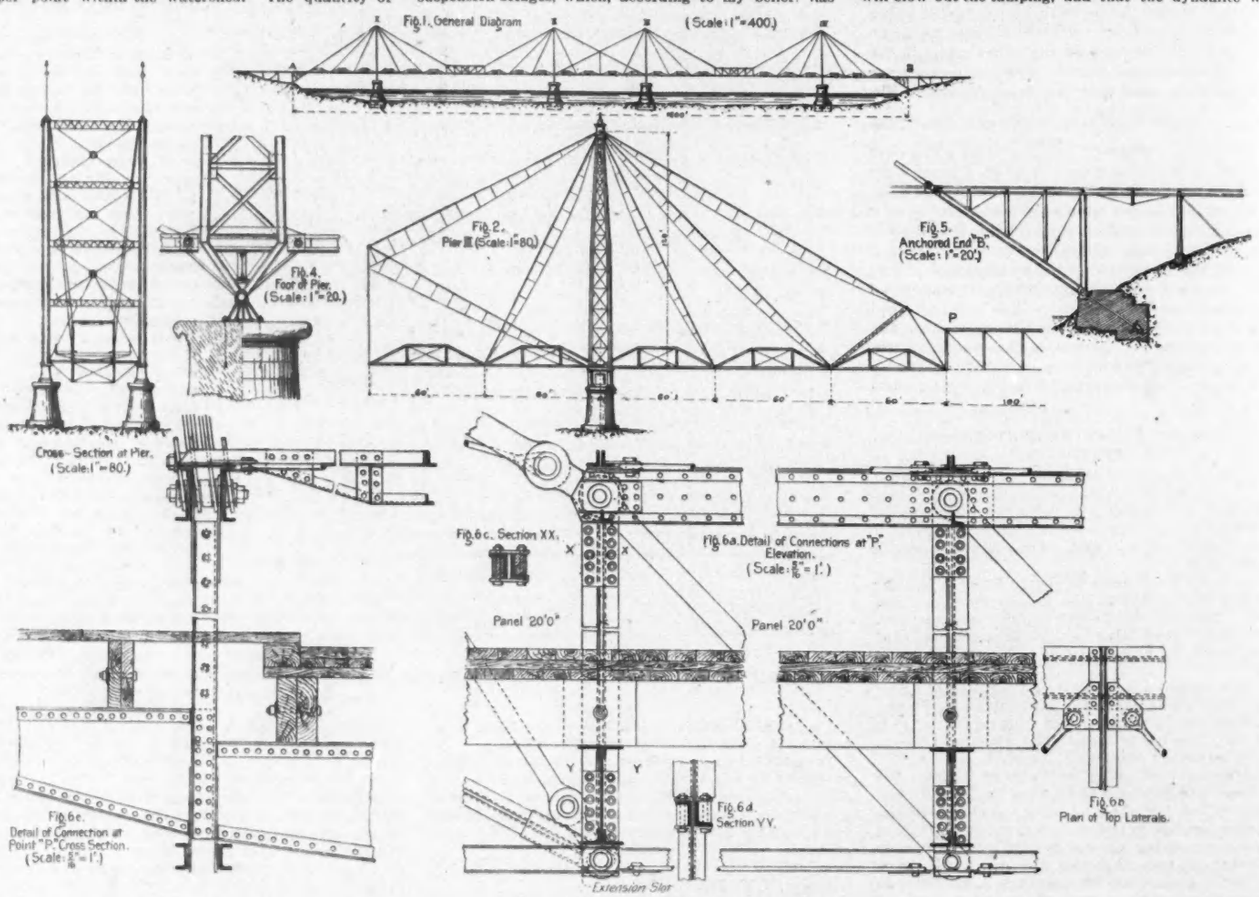


Fig. 1. General Diagram (Scale: 1"=400.)
Fig. 2. Pier II (Scale: 1"=80.)
Fig. 4. Foot of Pier. (Scale: 1"=20.)
Fig. 5. Anchored End "B." (Scale: 1"=20.)
Cross-Section at Pier. (Scale: 1"=80.)
Fig. 6c. Section XX.
Fig. 6a. Detail of Connections at "P." Elevation. (Scale: 5/16"=1'.)
Panel 20'0"
Panel 20'0"
Fig. 6e. Detail of Connection at Point "P." Cross Section. (Scale: 5/16"=1'.)
Fig. 6d. Section YY.
Fig. 6b. Plan of Top Laterals.
Extension Slot

A NEW PROPOSED SYSTEM OF SUSPENSION BRIDGES.

The drawing shows the disposition and general details of a roadway bridge. The bridge floor between I. and II. (Fig. 1) is composed of three 60-ft. spans on each side, connected by pins, and one 100-ft. span in the middle, all suspended at the piers by means of straight ties from a point at such a height that the weight of the suspension structure is reduced to a minimum.

An estimate will show that this system affords the greatest economy for long spans and variable live load, and allows the construction of the longest span for a certain maximum strain. The main ties are kept in straight line by a system of suspension which has for its only object the bearing of the weight of the ties. In large bridges these ties would have to be braced against the wind.

Although in this way every kind of special stiffening structure is avoided, yet the maximum of stiffness is reached, because the main structure suffers only the deformations which correspond to the tension and compression stresses in ties and towers, but none whatever of those due to bending, which necessarily occur in all arched suspension bridges.

One advantage of this system is the fact that the compression stresses in the bottom chord of the 60-ft. pier spans and also the tension stresses in the top-chord of the 100-ft. middle span are contrary to the stresses from the bending moments in these spans. Therefore, in large bridges, by a convenient disposition making the spans next the piers longer, a great economy in the dimensions may be attained.

To erect a bridge a span would be built forward from its end, the suspension chains for the ties located and then the heavy pieces of the ties put in place. The system adapts itself to any number of piers, the conditions of equilibrium being determinable and very easy to control.

Very respectfully, C. Steiner.

Chicago, Jan. 4, 1892.

THE DIRECTION OF NITRO-GLYCERINE EXPLOSION.

Sir: In your issue dated Dec. 26, 1891, in your editorial comments on my letter dated Dec. 14, 1891, you say "that the force of explosion will be expended in the line of least resistance," and cite the case of two holes, one loaded with black powder and one with dynamite, in both of which water tamping is used. You say that the powder will blow out the tamping, and that the dynamite will not, if holes are loaded, as ordinarily, with the cartridge containing exploder on top.

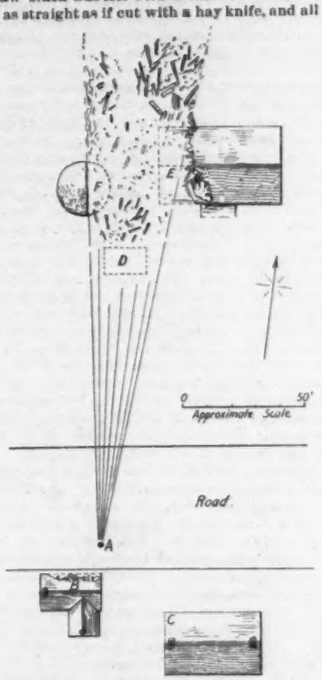
But I contend that if the exploder be placed at the bottom of the hole a charge of dynamite will exert enough upward force to blow out the tamping. I fully agree with you in the case of black powder, and believe the force of explosion to be in the line of least resistance, but on the contrary I claim that the force of a dynamite explosion can be directed at will.

I first noticed this peculiarity of nitro-glycerine explosions in 1878, and have since verified my first observation by noting the effect of nine accidental explosions of nitro-glycerine ranging in quantity from 12 qts., or 40 lbs., to six tons of explosives, as well as hundreds of personally conducted experiments with small amounts.

In 1878, near Sawyer City, McKean Co., Penn., a wagon driven by a "well shooter" and containing 60 qts. of nitro-glycerine, was overturned toward the right side of road and an explosion followed. On visiting the place about three hours later I noted the previous conditions as follows: On the south side of the road stood an old two-story farmhouse used as a boarding-house, standing back from road about 18 or 20 ft., and about 25 ft. west of this house stood a 1½-story cottage built on line of road and of hemlock boards. On the north side of the road stood, first, a corn crib over 100 ft. from the spot where the explosion took place, and beyond this stood a barn with oak frame, about 16 or 18 ft. high at eaves and 30 ft. wide by 5

ft. long. Near the west end of the barn stood a straw stack, bee-hive pattern, about 15 ft. high, from which the top had been taken off. (See sketch.)

The effect of the explosion was as follows: The windows in the boarding-house were broken; the front of the cottage was crushed in completely; the corn crib had disappeared; one end of the barn was shattered; one half of the straw stack was left with a face from top to bottom nearly as straight as if cut with a hay knife, and all debris



Sketch Plan of Nitro-glycerine Explosion Near Sawyer City, Pa.

was carried in a straight line north with an ever increasing width of track.

A very simple and almost conclusive experiment may be tried as follows: Take two 2 or 3-oz. bottles and fill with nitro glycerine, fit one with an exploder and let the exploder rest on the bottom of the bottle; place this on a sheet of boiler iron and explode. It will be found to have barely brightened the plate. Now fit No. 2 with an exploder fastened in the neck of the bottle and explode, and it will be found to have blown a hole completely through the plate.

Through lack of time I did not visit the scene of the late explosion at Nyack, N. Y., but I doubt not that if the location of buildings, and methods of, or habits of the men at work are known, the escape from death of the boys working in the cartridge room may be traced directly to this peculiarity of nitro-glycerine explosions.

Newark, N. J., Feb. 10, 1892. D. E. O.

[The control of direction in a nitro-glycerine explosion is a subject well worthy of extended investigation, especially as blasting operations are often in close proximity to valuable property. To the best of our knowledge no such investigation has been recorded by writers on nitro-glycerine. Our correspondent, in his bottle test, advances a strong argument in favor of his theory, and it is one easy of trial, though the extensive ring-gage tests conducted by Gen. Henry L. Abbot, with nitro-glycerine under water, point to somewhat different conclusions. In this case a 5-ft. ring carrying six symmetrically placed pressure gages, carried a dynamite charge fastened at the center of the ring. This charge was in a tin can placed vertically and was fired at the top by a detonator. The ring was suspended vertically from a buoy and the gages occupied what may be called the east and west (or horizontal) and the northeast, northwest, southeast, southwest points in the ring. With the ring submerged 35 ft. the two upper gages registered 20,366 and 17,576 lbs. per sq. in. and two lower 15,479 and 14,671 lbs. But in another experiment under similar conditions the upper pressures were about 16,000 and 21,000 lbs. as compared with about 15,000 and 16,000 lbs. on the two lower gages.—ED.]

CRUSHING STRENGTH OF CUBES OF STONE.

Sir: The two reports made to the Commissioners of the Albany Capitol, contain some valuable information which was new to me. In the first of these reports, I noticed two items that may be of interest just now to the profession:

1. The report says: "The power of resistance to compression of different sized cubes of the same material varies much. It would seem to be probable, as Professor Johnson has shown, that 'there is a direct relation between the power of resistance of the cube, and the product of the area of the base multiplied into the cube root of the area.'" The Professor Johnson referred to is doubtless Professor W. R., who made experiments about 1850 on the stone used on some of the public buildings at Washington. The above law would make the strength per square inch of cubes vary as the two-thirds power of the length of the edge. Gilmore's law claims that it varies as the one-third power, while a communication in Engineering News of June 30, 1888 (vol. XIX, page 511) shows that it varies as the cube of the edge i. e., that the strength per square inch is independent of the size of the cube.

2. The author of the pamphlets has compiled a table giving the crushing strength of cubes of stones as determined by seven or eight observers. No details are given as to the quality of the stone or the manner of making the experiments. Below is a summary of the table. Of the sandstones, seven 1½-in. cubes give an average strength of 5,789 lbs. per sq. in., and three 2-in. cubes give 2,159, while three 6-in. cubes give 1,856. Of the marbles, four 1½-in. cubes give an average of 8,233, and twelve 2-in. cubes give 6,227, while one 4¼-in. cube gave 3,748. Notice with both the sandstones and marbles, the larger the test specimen the less the strength per square inch, while both the above laws would require it to be larger.

Of the granites, four 1½ in. cubes give 10,345; eleven 2-in. cubes give 7,266; three 4-in. cubes give 13,671; one 4.18 in. cube gives 10,393, and two 4.25 in. cubes give 10,348. The above data for granite seem to be the results obtained by the experiments (Wyatt) on the assumption that the strength per square inch was independent of the size of the cube; but the compiler assumed Johnson's law, as above, to be correct, and reduced the observed results accordingly, giving the following as "the probable results if cubes of 2 ins. were used:" For the three 4-in. cubes 5,631 lbs. per sq. in.; for the one 4.18-in. cube 4,271, and for the two 4.25-in. cubes 4,259. Notice that, according to these reduced results, the larger the cube the less the strength. Notice that the compiler considered Johnson's law correct and then gave a series of results which contradict it.

The results are too uncertain and inconsistent to establish any conclusion or warrant further discussion.

Champaign, Ill., Aug. 18, 1890. I. O. Baker.

[In explanation the brief delay of 19 months in the publication of this letter, we may state that it was sent inclosed in a volume belonging on our shelves; that that volume was returned to its shelf, and that the inclosure was not discovered until there was occasion to consult the volume again. In the same inclosure was a list of errata in the writer's treatise on "Masonry Construction," which is given elsewhere after the same delay.]

Z-BAR AND PHŒNIX COLUMNS.

Sir: Mr. Milliken's criticism of my remarks in favor of Z bar columns in Engineering News of Jan. 9 is certainly very misleading in some particulars. Whether the Phœnix, or the Z-bar, or some other column section will carry the greatest concentric load per square inch of section, the length of the columns and the weight of metal being fixed, is certainly an open question. Mr. Milliken makes the claim that the Phœnix column is stronger than the Z-bar column, and bases that claim on the theories that enter into the construction of column formulas, with almost no reference to the empirical factors that represent the practical considerations peculiar to the construction of each. In my paper I did not discuss the relative strength of columns under concentric loading for the reason that these theories contain nothing new, and the effects of these practical considerations, at least for Z-bar columns, are not definitely known. Mr. Milliken does not know which column is the strongest, nor does any other man, nor can any one know until practical tests are made of both sections under specifications that would be equally fair to each.

In spite of his positive statement that "the Phœnix columns are the strongest form of strut yet designed," the engineers of this country as a whole do not allow a greater unit strain for that section than they do for plates and angles, or channels, or for Z-bars and plates made up in column or strut sections. It is true that the Phœnix column has no metal at the center, but it has a great deal near the neutral axis, and the radius of gyration of a ring is not as great as it is of a square of the same area and diameter taken about an axis at right angles to either side. More than that, if Mr. Milliken will refer to any good table of the strength of cast columns, he will find that the allowable unit strains on hollow, square and cylindrical columns show a greater strength for square columns per square inch than for round columns of equal diameters and lengths, and this does not go far to support his theory that the Phœnix section is so much the best one that there is no room for the use of others.

He says that Z-bar columns cannot easily be made straight and that in one case 27 were rejected out of 35. I do not know whether he refers to work done under his own jurisdiction or not, but in his book on Phœnix columns he makes reference to a similar case in Chicago, and I presume they are one and the same. If so, I am sure he must be mistaken. Probably no one in Chicago has been more intimately associated with the use of Z-bar sections than I have, and I am sure I should have known it had any such circumstance occurred in this city. The first Z-bars rolled at Uniontown by the Columbia Iron & Steel Co. were twisted, but we have had very little of that material in Chicago, and it in no sense represents the character of our Z-bar columns. When I read Mr. Milliken's letter I wrote to Estrada, Kenyon & Gray of Pittsburg, asking for their record for the past year. They report that they have inspected 2,000 Z bar columns for one Chicago contractor, and have not had occasion to condemn them for any cause, and that they have had no difficulty on account of twisting. I am also constantly looking for faulty work myself, and in the whole year have not seen one twisted column. Indeed, the only columns that have been criticised at all were a few basement columns in the Fair building, and this only on account of faulty milling at the ends, all of which was easily made good. It seems to me he must be equally mistaken in his statement that the bars themselves cannot be easily straightened. I have made inquiry of Carnegie, Phipps & Co., and they assert that they have no trouble on this account, and Estrada, Kenyon & Gray give the same testimony.

He tries to brush aside as of no importance what I said of eccentric loading. This cannot be done. The effects of eccentric loading are of great importance, and a building cannot be even decently designed in these days without giving this part of the problem due consideration. He says that an eccentric load "can be transmitted directly to the opposite flanges by means of a gusset plate." This is simply absurd. The strains cannot be transmitted in that way. Mr. Jas. Christie, M. Am. Soc. C. E., in a paper read in October, 1883, on the strength of columns and the results of extensive experiments made at Pencoyd, Pa., says, repeatedly, that "the slightest deviation from the requisite accuracy of centering rapidly reduced the resistance." If the slightest deviation makes a very marked reduction of strength, how much more will the resistance of the column be affected by six or eight inches of eccentricity, and it often happens that every load on a column from the bottom to the top of a large building is carried in just that way, on one side of a column.

He says in another place, that "any section having a minimum and maximum radius of gyration is not economical for use in a vertical post subject to a single direct load, as the calculations are only based with safety on the minimum radius of gyration." This is true, but the conditions named are the exception, rather than the rule, and every month architects are making new demands which require more in the way of irregular loading; and the fact that a column has a greater radius of gyration on one axis than the other is of really great advantage. It is natural that Mr. Milliken should oppose this idea, for the Phœnix column is not well fashioned to resist such loading effects. Much more might be said in relation to the other points he brings out. The excessive loads he quotes as used on floors and in some columns in New York buildings, as well as the excessive lengths, are extraordinary and might be entirely out of the range of the Z-bar sections that are now being rolled. But that is no reason for condemning the Z-bar in the great body of buildings where such conditions do not obtain.

My paper was intended as a description of what is being done here in this special line of work, and my judgment of the merits or demerits of any special section or method is entirely unprejudiced by any financial interest. The Phœnix column has some strong points and I should not hesitate a moment to use it if all considerations could put it on equal footing with the others. I wish Mr. Milliken could say as much of Z-bar columns in presenting his side of the case. Corydon T. Purdy.

Chicago, March 1, 1892.

INTERESTING TO MAKERS OF PAVING BRICK.

Sir: Thinking that information concerning the improvement of the roadways of the 'Blue Grass Capital" would prove interesting to some of your readers, I address you the following.

Owing to the increased population and necessary heavy travel attending thereon, it was found that macadam was a useless expenditure on the roadways in the business portion of the city, and a more substantial pavement was required. We have taken the first step toward reaching this end by paving with brick, (Hallwood block) laid on a concrete foundation.

We have in the last year completed about $140,000 worth of brick streets, and built about $15,000 worth of macadam streets, and also put down about $10,000 worth of pipe sewers. About March 15 we will let about $130,000 worth of brick paving, and I believe that during the present year there will be constructed here about $250,000 worth in this line. J. M. Corbin, City Surveyor.

Lexington, Ky., Feb. 29, 1892.

HARTFORD STEEL TIES AND 100-LB. RAILS; NEW YORK CENTRAL RAILROAD.

As noted in our issue of Feb. 27, the New York Central & Hudson River R. R. has placed an order with the Railway Improvement Co., of Chicago, for 33,500 steel ties of the Hartford type, which are to be laid on the four track line from the Grand Central Station, in New York, to Mott Haven, a distance of five miles. This section is the approach to the terminal station, and includes the Harlem tunnel, beyond which there is a considerable length of masonry viaduct. About three years ago the railway company decided, on the recommendation of Mr. Walter Katté, M. Am. Soc. C. E., Chief Engineer, to make a trial of steel ties in the interests of economy and efficiency of track, and in November, 1889, about 800 ties of the original Hartford pattern were laid on the main line of the Hudson River Division, near Garrison's, N. Y. Particulars of this track are given below, but the results of this practical test were so satisfactory as to lead to the adoption of steel ties for the line between the Grand Central Station and Mott Haven. On this line, over which run the trains of all the railways having access to the terminal station, there is an enormous traffic of regular trains, as well as of empty trains, light engines, etc., running between the station and the yards and roundhouses at Mott Haven. There is consequently much difficulty in effecting maintenance and renewals to track, especially in the tunnel, without interfering with the traffic, and one of the principal advantages of the steel ties here will be in the reduction of the amount of track work. The total number of train movements, including regular trains, empty trains, light engines, etc., is about 500 per day of 24 hours, about three-fourths of this traffic being during the day hours. Upon these ties will be laid steel rails weighing 100 lbs. per yard, which with good fastenings and joints, broken stone ballast and a well drained roadbed (all of which are being provided for) will make a heavy and substantial track, and probably one of the most substantial and permanent tracks on any railway in this country or abroad.

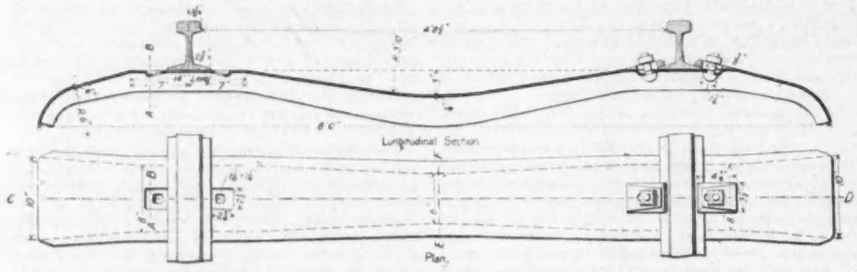


FIG. 1. LONGITUDINAL SECTION AND PLAN OF HARTFORD STEEL TIE; NEW YORK CENTRAL R. R.

The inventor of the ties is Mr. A. J. Hartford. The shape of the new ties, which is shown by the accompanying drawings, has been considerably modified from that of the original pattern, and these changes have been embodied in later patents. The original ties, as described further on, were of rolled steel, with the top surface horizontal and having a groove rolled throughout its entire length. The ends were curved down to hold the ballast. The new ties are of pressed steel, and, instead of the groove, pockets are stamped in the top surface of the tie to give the necessary inclination to allow of the use of straight bolts to secure the rail clips or clamps, instead of the bent bolts used with the original form of tie. Several other changes and improvements have been effected, and the shape of the tie, and the shape and arrangement of the fastenings are very clearly shown on the drawings, for which we are indebted to Mr. Katté. The cost is $2.50 per tie, including fastenings, while that of the original ties was $3, also including fastenings.

Each tie is pressed from a steel plate 8 ft. 4 ins. long, 1 ft. 1⅝ ins. wide, and ¼ in. thick. The finished tie, Fig. 1, is of channel section, 8 ft. long; 6, 8 and 10 ins. wide on top at middle, rail seats and ends, respectively; 9 and 10 9/16 ins. wide over the bottom at middle and rail seats; about 3¾ ins. deep at the middle, and 2¾ ins. deep at the rail seats, as shown by the cross-sections, Fig. 2. The tie has a uniform thickness of ¼ in. The weight, including rail fastenings, is 100 lbs. per tie. The rail seats are horizontal, and beyond them the tie slopes downward and has the ends bent down to a curve of 6 ins. radius to retain the ballast, the total depth from top of rail seat to bottom of end of tie being 7 ins. The middle of the tie is bent downward to a curve of 3 ft. 10 ins. radius. On both sides of each rail seat is stamped a pocket 2⅛ by 2¾ ins., as shown in Fig. 3, the bottom of which is inclined downward from the rail with a slope of 4 to 1, and has a hole 1 1/16 ins. square to take the 1 in. square neck of the bolt. The rail fastening consists of two clips to each rail, 4¾ ins. long and 3⅛ ins. wide, the end of which holds the rail flange. The bolt hole in the clip is slotted, 2 7/16 ins. long and 15/16 in. wide, with semi-circular ends of 15/32 in. radius. These clips may be of pressed steel or annealed malleable iron. Each clip is secured to the tie by a ⅞-in. bolt, with a neck 1 in. square, and a nut 1¾ ins. square, having the Harvey grip thread, which obviates the necessity for a nut lock. The ties are spaced uniformly 36 ins. apart, c. to c., with an extra tie under each rail joint, making a three-tie joint with ties spaced 18 ins. c. to c.

The 100-lb. rails are of Mr. P. H. Dudley's standard section, which has been adopted for all weights of rails on the New York Central & Hudson River R. R., and is similar to the standard 80-lb. rail of that road (Eng. News, April 21, 1888), but is 5¼ ins. wide over the base and 6 ins. high. An order for 3,000 tons has been placed with the Lackawanna Iron & Steel Co., of Scranton, Pa., and rolling has been commenced. The rails will be laid with broken, three-tie joints, spliced with 36-in. angle splice bars and six bolts. The flanges of the splice bars are narrow and are slotted for the rail clips, which thus act to prevent creeping of the rails. The ballast will be of broken stone, covering the ties except over the rail clips. From the outer clips the ballast will be extended straight across to the next track or the side wall of the tunnel, thus giving a good shoulder to keep the track in line, which cannot well be maintained when the ballast is sloped down to a middle drain. Between the rails the ballast is crowned 3 ins., thus giving a depth of 6 ins. over the middle of the tie, which is depressed 3 ins. as shown.

This work will involve the entire reconstruction of roadbed, and the subgrade will be altered to give proper drainage planes to a central drain. On the tunnel section each single track side tunnel will have a drain at the side nearest the inner wall, with cross drains to the central drain of the double track tunnel between the side tunnels. This work is now in progress, but owing to the heavy traffic it can only be done at night, two tracks being given up to the track department from 9 a. m. to 6 p. m. The tracklaying will be done this spring.

On the experimental track at Garrison's, laid with the original form of Hartford tie, the cost for maintenance for the year 1891, was only $25 for the 800 ties, or 3⅛ cts. per tie, while the line, surface and joints were in excellent condition when inspected and run over by Mr. Dudley's dynagraph car, on the annual inspection trip over the road last autumn. The following description of the original form of the Hartford tie, and the arrangement of the track at Garrison's, are taken from the report on "The Substitution of Metal for Wood for Railway Ties," made by Mr. E. E. Russell Tratman to the U. S. Department of Agriculture in 1890.

New York Central & Hudson River Railway.—The Chief Engineer of this road, Mr. Walter Katté, having recognized the importance of the metal track question to the great trunk lines of railway, became desirous of obtaining some reliable data based upon experiments made under his own supervision. The company authorized an expenditure of $2,500 for the purpose of procuring such ties and testing them upon its own track. Various forms of ties used in foreign countries were examined, none of which, however, were considered to meet entirely and satisfactorily the conditions of American railway practice. The Hartford tie, with certain modifications to be made at his suggestion, seemed to Mr. Katté the best suited of any he had examined, and as it could be made in this country under his own observation as to manufacture, test of material, etc., he concluded it was the best one he could get, at least to start with, in investigating practically the question of metal ties. It is intended to conduct a close investigation of the comparative cost of maintenance, expenditures, renewals, etc., as compared with ordinary wooden ties. About 800 of the steel ties were purchased and were laid in double track on the main line. The company's standard system of track is used, consisting of good broken-stone ballast, with 80-lb. flange rails, three tie supported joints, and six-bolt angle-bar splices 40 ins. long. The rails are laid to break joint. It was expected to have these ties laid in April, 1889; owing to delays in manufacture, etc., they were not put in the track until November, 1889. They are laid for about a quarter of a mile on the main line, just south of Garrison's Station, Hudson River division. They are of two lengths, 8 ft. and 8 ft. 6 ins. They were at first laid in gravel ballast of mediocre quality, but this has been replaced with broken stone, in accordance with the company's approved form of track. The flanges of the angle-bars are notched to allow the clamps to bear on the rail flanges.

The following particulars are from a statement and drawings furnished in January, 1890, by Mr. Katté: The ties were laid in November, 1889, on an experimental section of double track about a quarter of a mile long. The section is level and straight. The line has the heaviest kind of freight and passenger traffic. Passenger engines, with a weight of 36 tons on four driving wheels and a driving wheel base of 6 ft., pass over these ties at speeds of 40 to 55 miles per hour. The ties have not been in use long enough for the expense of maintenance to be determined. Apparently, however, it is thus far no greater than with wooden ties. The arrangement for curves is the same as for tangents, any adjustment of gage being effected by the fastenings. The rails weigh 80 lbs. per yard and have supported joints. The reason for using these ties was the desire to secure economy over wooden ties and to obtain a superior attachment of the rails to the ties. The results have so far been quite satisfactory. There has been no trouble with maintenance nor with the rail fastenings. No breakages have occurred. The attachment of the rails to the ties is much superior to the ordinary system of spiking. The wooden ties are of Southern yellow pine. They cost 55 cts. each, delivered in New York, and have a life of from 7 to 10 years. The climate is variable, humid, with extremes of temperature. There is no record of the effects of the same on metal or wood. I am of opinion that the rolled metal tie is essentially a requisite for first-class permanent way in this country. Having investigated the relative economy of metal and wooden tie systems for a term of 50 years, I am led to believe, as the result thereof, that upon the basis of 55 cts. for a wooden tie and $3 for a steel tie, and under the conditions of traffic and maintenance expense existing on this line the relative economy is from 8 to 12% in favor of the metal system. The general advantages which I recognize in the metal system are: 1, Superior and more effective fastening of rail to tie; 2, Better hold of metal cross tie with curved ends in the roadbed ballast, thereby preserving alinement both in straight line and curves much more effectively than with wooden ties; 3, Increased and effective resistance to tangential pressure on curves with overturning tendency and resistance to creeping of rails, especially on steep grades; 4, The clip and bolt fastening to the tie avoids the necessity of double spiking the rail braces on curves; 5, Immunity from destruction of wooden ties by fire from coals dropped from locomo-

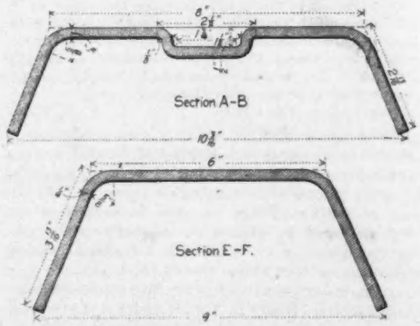


Fig. 2. Cross-Sections of Hartford Steel Tie.

tives and other causes; 6, The greater commercial value of the scrap material when worn out.

The ballast is about 24 ins. deep. It consists of a 6-in. bottom course of rough quarry spawls, 4 to 6 ins. diameter, and an 18-in. upper course of crushed rock 2 ins. diameter. The ballast is brought up level with the tops of the ties. From the center of the rail to the outer edge of the ballast is about 6 ft. 6 ins. Four arrangements of spacing of the ties are being tried. The rails are laid to break joint in all cases with supported joints: 1, Thirteen lengths of 30-ft. rails, with 12 ties to a rail length; the three joint ties are spaced 18 ins. c. to c., and the intermediate ties 3 ft. 2, Fourteen lengths of 30-ft. rails with 12 ties to a rail length; uniform spacing of 30 ins. c. to c. 3, Fourteen lengths of 30 ft. rails with 14 ties to a rail length; the three joint ties are spaced 18 ins. c. to c., and the intermediate ties 2 ft. 4½ ins. 4, Fourteen lengths of 30-ft. rails with 14 ties to a rail length; uniform spacing of 2 ft. 1½ ins. c. to c. The close spacing of the ties at the rail joints is considered necessary for the existing severe conditions of traffic.

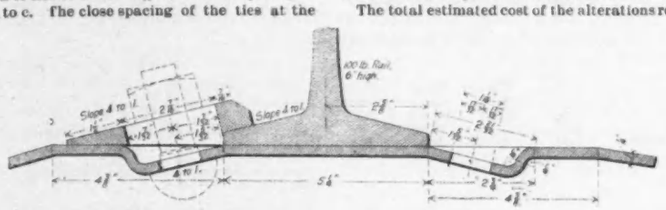


FIG. 3. RAIL FASTENINGS OF HARTFORD STEEL TIE; NEW YORK CENTRAL R. R.

ABOLITION OF GRADE CROSSINGS IN MASSACHUSETTS.

The movement for the abolition of grade crossings in Massachusetts is on the whole making good progress. In 1889 the report of the Board of Engineers on the gradual abolition of grade crossings in Massachusetts was presented to the legislature. The engineers who made this report were appointed by Governor Ames, and the Board was made up as follows: A. W. Loeke, of North Adams, Wm. O. Webber, of Boston, and Geo. A. Kimball, of Somerville.

The legislature of that year and the years following passed an act for the abolition of grade crossings by which the railway was to pay 65%, the town not over 10% and the remainder to be paid by the state. Under this act a large number of unimportant crossings have been abolished already in different parts of the state, but in the near future it seems probable that several large undertakings will be commenced.

Recently the city of Newton and the Boston & Albany R. R. came before the legislature and asked for legislation by which they proposed to raise the Boston & Albany with its four tracks through the city of Newton, thereby abolishing nine crossings. The city of Northampton also came before the legislature with A. W. Locke as its engineer, and proposed to abolish all the crossings within the thickly settled parts of Northampton. The question of raising the tracks of the Boston & Providence R. R. through Roxbury, a distance of about four miles, was also under consideration.

The city of Brockton is now negotiating with the Old Colony R. R. for raising the tracks through that city and abolishing twelve grade crossings. That portion of the railway running through the thickly settled part of the city it is proposed to raise and carry the streets under. Mr. J. W. Ellis is Consulting Engineer for the company, and Mr. Geo. A. Kimball for the city.

The Board of Engineers, appointed by the city of Worcester to report on the abolition of all grade crossings in that city, have recently made their report, recommending the change of grades of with the tracks and streets at a total cost of about $3,000,000.

The report of the Railroad Commissioners, issued this week, and abstracted elsewhere, makes the following summary of the existing situation in the state:

The whole number of highway grade crossings is 2,219, being a net decrease of 15 for the year. The number of grade crossings abolished during the year was 21, but 6 grade crossings have been added to the list, owing to a more accurate count, so that the decrease for the year is only 15.

The following table shows the extent to which action has been taken in the abolition of grade crossings since the passage of the act to promote the abolition of grade crossings. (Statutes 1890, chapter 428.)

Proceedings founded on agreement	1	
" " " R. R. petition	39	
" " " city petition	45	
" " " joint petition	8	93
Proceedings discontinued	2	
Commission not appointed	10	
" has not reported	43	
Abolition of crossing recommended by discontinuance or avoidance	2	
Consolidation with another road	5	
Carrying road over railway	20	
" " under railway	11	93
Work not begun	73	
" in progress	7	
" completed	13	93

Of these 93 cases 39 are on the Boston & Albany, and 23 on the Old Colony. No other road has more than 8 cases.

The total estimated cost of the alterations recommended up to June 30, 1891, was $379,959. Of this amount, the portion to be paid by the commonwealth was $94,999. Thus far no actual payment has been made by the commonwealth on account of proceedings under the act. During the coming year, however, the commonwealth will undoubtedly be called upon to make payments.

IRON AND STEEL WORKS IN THE UNITED STATES IN 1891.

The new directory of iron and steel works in the United States for 1891, just published by the American Iron and Steel Association, contains a wealth of matter relating to these important industries. Without going into detail the present status can be set forth about as follows:

Blast furnaces in active operation, 569, or 6 furnaces less than at the close of 1889. There were 52 new furnaces started, of which one was anthracite, 35 were coke and 16 charcoal furnaces; 58 furnaces were torn down or abandoned in the same period. Of the 569 now in use, 164 use anthracite coal or mixed anthracite and coke, 267 use bituminous coal or coke, and 138 use charcoal. The furnace building boom in Alabama was checked last year. At the close of 1887 there were 24 completed furnaces and 19 building in that state; in 1889 there were 44 furnaces and 8 building, while in 1890-91 only 9 furnaces were built in Alabama, and at the close of 1891 not one new furnace was being constructed in the state.

The annual aggregate capacity of the 569 furnaces is placed by the owners at 16,296,793 tons net, or an aggregate weekly capacity of 313,400 net tons, and a weekly average of 551 tons for each furnace. In November, 1887, the weekly average per furnace was 363 tons, and in November, 1889, it was 440 tons.

The remarkable growth in the last four years can be better expressed as follows in aggregate capacity:

	Net tons.
Nov., 1887, 582 furnaces	10,990,963
Nov., 1889, 575 "	13,168,233
Jan., 1892, 569 "	16,296,793

The last directory enumerates and describes 460 completed rolling mills and steel works in the United States, of which 425 contain trains of rolls and 35 have no rolls. Two years ago there were only 445 similar works, and in the mean time 43 new rolling mills have been built and 28 abandoned. In January, 1892, there were 18 rolling mills and steel plants in course of erection. Puddling furnaces increased in number from 4,882 in November, 1887, to 4,914 in November, 1889, and to 5,120 in January, 1892.

Within the last two years six new standard Bessemer plants have been built, making the present total 46 standard plants with 95 converters, and two more are being built. In addition to the Bessemer plants there are now 5 Clapp-Griffith and 4 Roberts-Bessemer steel plants, with 9 and 6 converters respectively. No new plants of these types have been built since 1889.

The open-hearth steel industry has made even greater advances in the last two years than has Bessemer steel. In this time 17 new open-hearth steel plants were built and only two abandoned, making a present total of 71 plants completed and 4 plants in process of construction. Crucible steel making, while showing no progress as an industry, does not retrograde, and the directory describes 45 completed plants and one being built, as compared with 43 completed and 3 building two years ago. Basic steel making, chiefly by the open-hearth process, has only risen to a position of importance in two or three works in Pennsylvania. The South only has one establishment making this steel.

In November, 1887, there were in the United States 81 rolling mills devoted in whole or part to the production of cut nails and spikes, containing 6,350 nail machines. In November, 1889, 75 mills contained 6,066 machines, and in January, 1892, the number of mills had declined to 65 and the number of nail machines to 5,546. But the wire nail industry has grown rapidly, from 37 wire nail works, two years ago, to 51 scattered over 16 states, with a much greater average capacity than the older mills.

As a result of the McKinley tariff bill, which went into effect on Oct. 1, 1890, the directory describes 20 works in the United States either making or preparing to make tin plates or terne plates, and 10 aditional tin plate works are now in course of erection.

Among the miscellaneous works described are 21 locomotive works, not including those operated by railway companies, 31 wrought-iron pipe works, 43 cast-iron pipe works, 69 car axle works, 109 car wheel works and 105 car works, not including those operated by railway companies in the three latter classes.

The use of natural gas as a fuel in rolling mills and steel works has greatly decreased within the last two years. The record of the works using this fuel in the manufacture of iron and steel was 6, 1884, 68 in 1886, 96 in 1887, 104 in 1889, while in Jan., 1892, only 74 were using natural gas in whole or part. Of the works still using this fuel 45 are in Pittsburg and Allegheny Co. and 11 elsewhere in Western Pennsylvania. Of the others, one is in West Virginia, 11 in Ohio and 6 in Indiana. Two years ago there were 69 works so run in Pittsburg dan Allegheny Co. This decline in use is due to a shrinkge in the supply, and the manufacturers have either returned to the use of bituminous coal or use producer gas made from coal.

Canada has 5 completed blast furnaces and 2 building and 12 rolling mills. Mexico has 12 completed blast furnaces and 1 building (all charcoal) and 5 completed rolling mills and 1 projected.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Measures to Prevent Waste of Water.

When the franchise of a water company provides the maximum charge for a specific service and also provides that the company may make all needful rules and regulations in connection with supplying water to consumers, and for shutting off of water for non-payment of rate or waste, and where the company adopts a rule to the effect that it may introduce a meter to ascertain the quantity of water being used when waste is suspected, the company may charge its schedule meter rates for all water used in excess of a fair amount for the purpose in question and may shut off the water in case of non-payment.—Geo. and H. B. McDaniel vs. Springfield W. Wks. Co., Supreme Court of Mo., decision Feb. 15, 1892.

Appointment of Non Resident as City Engineer.

Under Laws N. Y. 1888, c. 214, tit. 2 sec. 2, which provides that no person shall be elected or appointed to any city office unless he is a resident elector of the city, though one is employed to perform the duties of city engineer until he shall become a resident elector, the office remains vacant. Laws N. Y. 1888, c. 214, tit. 3, sec. 2, provides for the appointment of city officers, and declares that if the council shall fail to appoint any such officer within three weeks after any such vacancy occurs it shall be the duty of the mayor, immediately on the expiration of said three weeks, to appoint such officer and fill such vacancy. Where the city engineer resigned, after the expiration of three weeks the power of the council to fill such vacancy ceased.—Ex Rel. Callie v. Merrick, Sup. Ct. of N. Y., 16 N. Y. Supp. 246.

The Holyoke Water Power Co. will build a new stone dam this summer, below the present wooden dam, at an estimated cost of $500,000.

A suit to recover costs for the infringement of a car-coupler patent has just been decided against the Manhattan Elevated Railway Co., which uses a peculiar close coupling of the link-and-pin type on its rolling stock. The defendants set up the plea that the invention was of little value, but that to make a change in the couplings at the present time would cause much inconvenience to the defendant and to the public. The Court held that this was not a valid defense, and ordered the couplings removed from a fixed number of cars per week.

THE COMPARATIVE MERITS OF VARIOUS SYSTEMS OF CAR LIGHTING.

[The previous articles in this series have appeared in the issues of April 18, 25, May 2, 9, 16, 23, Aug. 15, 22, 29, Sept. 5, 19, 26, Oct. 10, 17, Nov. 14, 21, and Dec. 5, 19, 1891.]

XIV.

THE FIRST COST OF CAR LIGHTING PLANTS.

The preparation of any definite estimate of the cost of lighting cars by any system is necessarily a delicate matter. Most, if not all, of the items will vary considerably on different roads and in different sections of the country. An estimate which is even comparatively fair for one road or one part of the country will not be quite so for any other. To minimize these difficulties we have postponed the conclusion of these articles nearly three months, in order to gather all possible data. They cannot be wholly eliminated, and hence the tolerably accurate general average which we think we have reached, and give below, will require correction for the circumstances of each particular road.

The first cost of equipping cars with oil lamps varies between $115 and $225 per car, according to the make and style of lamp used. This provides for six double chandeliers, or their equivalent in more powerful single burners, and a closet light of little cost. It is a moderate estimate to take the cost of a good modern equipment at $175 per car, including all cans and storage and cleaning facilities off the car. Some lamp equipments, however, run up to $225 per car or more, for the above number of lights. The oil used, when actually of 300° F. fire test, is not much more dangerous than kindling wood to have about, and hence requires no special care or facilities for storage. Much of the oil actually in use, however, is of much lower proof.

The yearly depreciation of such a plant is extremely difficult to estimate accurately. Mr. Geo. Gibbs, in his paper on car lighting,* estimates the depreciation at only 5%, but this in our judgment is far too small. The cases in which lamps are actually usable for more than 10 to 15 years are not more numerous than those in which they are condemned in less, as nearly as we can ascertain. Hence, 7% to 10% seems a fairer allowance. We assume 8%.

The cost of compressed oil gas plant, complete on the car, is thus stated to us by the Safety Car Heating and Lighting Co.:

1 receiver, 9 ft. 6 ins. × 20½ ins. diam., holding 220 cu. ft. at 10 atmospheres	$87
5 lamps (4-flame) having 2.75† cu. ft. per hour as a maximum, or 13¾ cu. ft. per hour in all, $25 each	125
Regulator, piping, etc	66
Labor applying	10
Total per car with one receiver	$288
Extra cost of additional receiver	87
Extra cost of more finely finished lamps at $30 each	25

The receivers are made of various sizes, varying from 6 ft. × 16½ ins. diam. to the size above given, which is the largest generally used. If more capacity is desired, two or even three receivers are used. If we assume the receivers to be able to deliver 10 to 11 times their cubic contents, or 220 to 242 cu. ft. of gas, there will be 16 to 17½ hours of supply at the maximum rate of combustion, for each receiver. As much as 22 hours per receiver is obtained with only four lamps, and no doubt this service, or more, may often be realized with five lamps in sleeping cars, where lights are turned down after certain hours; but it cannot be realized with full lighting power. It is, however, one of the admitted advantages of this system of lighting that lights can be turned down freely, which is possible neither with oil lamps nor carbureters, or that some lights can be extinguished and others left burning, which is not possible with the carbureter plant without running the risk that some lamps may give out without notice, as also another far greater risk, not generally recognized or understood, which will be pointed out in our concluding article on comparative safety. The Pintsch receivers may be considered, therefore, as furnishing 18 to 20 hours' supply.

The Frost Carbureter Co., in some of their comparative statements, give the cost of compressed oil gas plant, complete on the car, at $317, with five lamps and one tank, against $288 to $313 by the statement above. To this the Frost company adds $100 per car to allow for the cost of gas works.

Mr. Geo. Gibbs, of the Chicago, Milwaukee & St. Paul, in his paper before referred to, gives the cost of Pintsch plant complete on the car at $370.25, with only four 4-flame lamps and a closet lamp. To this he adds the large sum of $181.75 as the pro rata of each car for fixed plant. Both of these estimates, but especially the latter, were objected to by the Pintsch company; and Mr. Gibbs stated in explanation that his estimate was only for one particular road, on the assumption that the full capacity of the gas plants was not utilized.

The Pintsch company claim, however, that a charge of even $100 per car for fixed gas works is unfairly high for purposes of comparison, though they admit it may at times reach that figure or more. Of course this must always be a more or less indeterminate item, but the ultimate tendency must be to supply about as many cars from each plant as its capacity permits. Even under these latter circumstances the cost of fixed gas-making plant per car will vary greatly, as follows:

Gas plant supply'g 5'0 cars	Capacity cu. ft. per day.	Cost of Apparatus.	Cost of B'lding.	Total cost.	Cost per car.
200 "	10,800	9,500	4,100	13,600	68
100 "	6,000	7,500	3,000	10,500	105

The costs above given are the same as those given by Mr. Gibbs.*

Gas plant supply-ing.	Capacity cubic feet per day.	Cost of Appa-ratus.	Cost of Building.	Total cost.	Cost per car.
60 Cars.	3,000	$3,900	$1,500	$5,400	$90
150 "	8,000	6,100	1,600	6,700	45
200 "	10,800	7,500	3,000	10,500	52
300 "	18,000	10,400	4,100	14,500	40
500 "	24,000	11,180	4,500	15,680	32
900 "	45,000	18,500	7,500	26,000	29

In order to insure a full supply where needed to only 466 cars, however, Mr. Gibbs allowed for one 500-car plant, two 200-car plants and four 100-car plants, or seven in all, thus providing capacity for the potential supply of 1,300 cars, or nearly three times the actual number to be supplied. This plant was estimated to cost $84,700, or $181.75 per car actually supplied, as above stated. However prudent it might be to do this in making an estimate of the immediate future for some one road, it is obviously too high for the purpose of this investigation, which is to determine what system has greatest merit for general use. The cost per car potentially supplied by Mr. Gibbs' plant was $65. We shall, therefore, assume $100 per car as a reasonable general estimate for this item. Under present conditions this is low, but it would probably prove too high after the system was once in general use.†

The Erie is now supplying some 550 cars from a single works costing $17,000, or about $31 per car. The above allowance would permit them to expend $149,000 in all for supplying less than three times as many passenger cars, 1,490, which is all they own, to which should be added a large further sum for the sleepers supplied. The New York Central is also supplying all its through cars from a single works. The cars make the round trip to St. Louis or Chicago with one charging of two to three tanks.

It is to be remembered that it is by no means necessary to erect works at every point where it may be necessary to supply cars. Tank cars carrying three large tanks, holding some 10,500 cu. ft. of gas at 12 atmospheres, will supply 840 car-hours of maximum combustion, equal to about 280 car-days, before they are exhausted. Details as to current practice in this respect were given in our issue of Aug. 29, 1891, p. 197.

The annual depreciation of the compressed gas plant on a car, while impossible to estimate exactly, should probably be estimated lower than for any other form of lighting, because it is the simplest of all, consisting only of a supply tank with connected regulator, gas piping and gas burners. The depreciation of the tanks, gas pipes and gas burners will be almost nil; the regulator has been shown by experience to be an exceedingly durable device; the ornamental and reflecting parts of the lamps are alone likely to suffer much with time. The gas making plant, however, depreciates more rapidly. We believe a depreciation allowance of 5% per annum for the car plant and 10% for the fixed gas-making plant to be a closely approximate estimate.‡

The Frost carbureter plant requires practically no plant off the car. The company claims with truth that a metal shed costing $200 will store 80 to 111 two-gallon cans of gasoline, which by sufficiently frequent recharging will be a sufficient store for supplying 100 cars. The expense for plant off the car is so small that it may be neglected.

The cost of the plant on the car is thus given by the company:

Cost of air tank, regulators, safety valves, closet and tank needle valves, copper tubing for air supply, deck check and safety valves and combination dust guard and check valve	$117.95
Cost of each carbureter and lamp complete with copper tubing and brass tee to connect with deck pipe, $77.86 each—for five lamps	389.30
	507.25
To this add labor applying, say	15 00
Total per car	$522.25

A statement furnished by the Pennsylvania road of somewhat earlier date, shows a somewhat smaller cost and is in more detail, as follows:

Tank, 10 ft. 3 ins. × 16 ins	$25.00
Combination regulator and safety valve	20 00
Closet needle valve	2 00
Tank needle valve	2.75
Combination dust guard and check valve	3.00
Deck check valve	1.55
Deck safety valve	1.48
Brass unions, ½ in., 4 at 45 cts. each	1.80
Brass Ells, ½ in., ⅛ in	.25
Brass Ells, ½ in., 4 at 21½ cts. each	.85
Copper tubing to suit length of car	15.00
Total for parts independent of lamps	73.68
Each lamp	$30.00
Carbureter for same, complete	50.00
Brass tee, ½ in. × ⅛ in	.25
Total per lamp	80.25
Total for five lamps	401.25
Total cost plant complete for 1 car, 5 lamps	474.93
To this add labor applying, say	15.00
Total cost on car	$489.93

This shows a cost some $33 less than the company's figures, though it is for a somewhat more costly plant, the regulator and other parts having been somewhat modified and cheapened since the statement was made up, as explained in our issue of May 9, 1891. The difference may be due in part to the fact that the Pennsylvania supplied a good many parts from its own shops. We take the company's figures.

The annual rate of depreciation of the Frost carbureter plant may be taken as less than that of oil lamps and more than that of compressed gas car plant. With respect to the tank, reducing valve, piping and (in some degree) the burner, the gasoline and fixed gas plants stand on an equality; but there are the carbureters, check valves, dust guards, safety valves and indicators, which, as a whole, are more subject to deterioration than the parts of the plant which are common to all gas-lighting systems, while the flame of the lamp itself does not remain constant after once lighting, but requires regulation from time to time as the temperature of the plant varies, thus tending to more rapid depreciation.†

On the other hand the evidence is very strong that the carbureter proper, including its interior wicking, is very durable. We have seen pieces of carbureters, which had been in use for many years, cut open to show their condition, which seemed to be for all practical purposes as good as new. Keeping all circumstances in view, we think that an annual depreciation allowance of 7%, against 5% and 10% with compressed gas plant, and 8% with oil lamps, is as relatively fair an estimate as can be made.

On this basis, and charging interest on first cost at 6%, which is as low a rate as most railways care to earn on investments, we have the following comparison of the three plants in question:‡

Oil lamps	$167	5%	5%	10%	$16.70
Pintsch gas	in car. 370	5%	5%	10%	37.00
	fixed. 182		10%	15%	27.30
Carbureters	586	5%	10%	15%	80.40

The following is from estimate prepared some years ago

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* Eng. News, March 7-14, 1891.

† In the photometric tests (Eng. News, Dec. 10, 1891, p. 588) these lamps burned 2.75 cu. ft. per hour, but 2.5 cu. ft. is probably a fairer average for actual service.

* The Safety Car Heating and Lighting Co. furnishes us the following revised list of the gas works which they are now prepared to furnish and erect, giving the capacity in cubic feet per day and number of cars they will supply, the cost of apparatus, cost of building, total cost erected, and cost per car erected, stating that since they furnished the above data to Mr. Gibbs they have arranged for works of smaller capacity than those specified to him.

† Mr George Gibbs, who has done us the favor to examine proofs of this article before publication, advises us that he considers this a "very fair general average."

* We are informed that with compressed oil gas, as handled in the Pintsch plant, no liquid hydrocarbons are deposited in the distributing pipes or on the car, as happens with some coal gas plants. The difference is due to difference of process more than to difference in the gas.

† An officer who has had considerable practical experience with the system writes us: "The sheet iron and pasteboard casing of the carbureters is much exposed to cutting by cinders, etc., and must be renewed very often at considerable expense."

‡ Other estimates, which we do not consider as correct as the above, after careful comparison have been as follows.

Estimate of Geo. Gibbs, C. M. & St. P. R. R.:

Oil lamps	$167	5%	5%	10%	$16.70
Pintsch gas	in car. 370	5%	5%	10%	37.00
	fixed. 182		10%	15%	27.30
Carbureters	586	5%	10%	15%	80.40

System.	Cost new per car.	Annual interest.	De-pre-c'n,	Total p. c.	First cost charges per year.
Oil lamps, 6 double chandeliers	$175	6%	8%	14%	$22.50
Pintsch gas, 5 lamps, (4-burner)	313	6%	5%	11%	34.43
	160		10%	16%	16.00
Carbureters, 5 lamps	522	6%	7%	13%	67.86

These first cost charges are to be added to the annual operating cost to get the total cost per year. These latter we will now proceed to estimate.

THE NEW WATER-WORKS RESERVOIR AT WHEELING, VA.

In 1889-90 a distributing reservoir built by the city of Wheeling in 1888-89 was enlarged to a capacity of 4,000,000 and generally remodeled, the reservoir as first constructed having leaked and proved unsatisfactory in other ways. The present reservoir is about 500 ft. from and 100 ft. above the old reservoir, or about 1,500 ft. from the pumping station and 230 ft. above low water in the Ohio River, the source of supply. An 18-in. force main connects the pumps with the new reservoir and a 20-in. main connects the new reservoir with the old and with the city mains.

The reservoir is excavated in shale, the excavation being lined with an ashlar masonry wall, 4½ ft. thick at the bottom, having a batter on the inside of 2 ins. to 1 ft. The wall is about 14 ft. high, not including the coping, and the space between the rear of the wall and the excavation was filled with grout.

The bottom of the reservoir is covered with 3 ins. of concrete with 1 part of Portland cement to 5 parts fine and coarse sand and fine gravel. Where necessary to bring the bottom to surface a concrete filling was used made of shale and American cement.

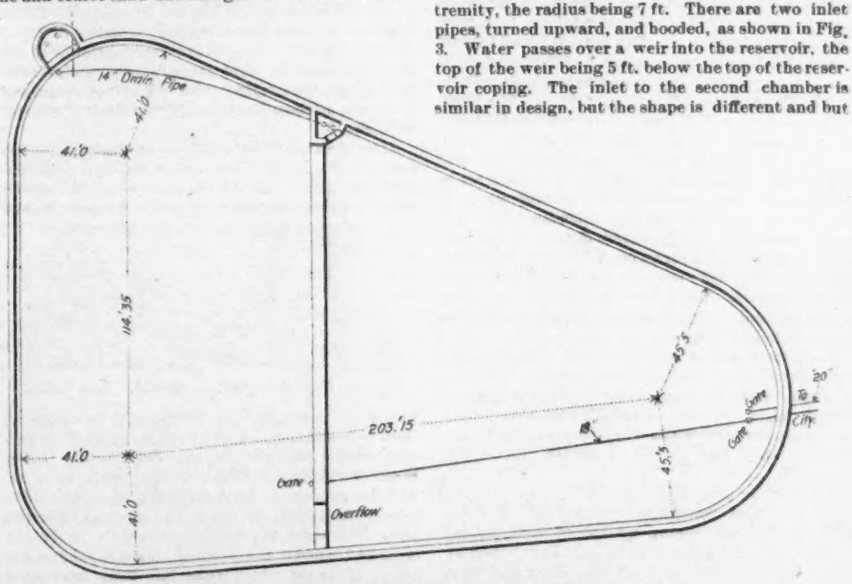


FIG. 1. PLAN OF RESERVOIR, WHEELING, W. VA.

The reservoir is irregular in shape, as shown by Fig. 1. Its length is about 240 ft. and its width about 190 ft. at the widest end, the narrower end being curved. It is in two compartments of nearly equal size, either one of which can be used independently of the other, provision being made for admitting water to either basin through a separate inlet chamber. It is intended, however, that water shall be admitted to the upper basin and flow to the lower over the weir in the partition wall. The 18-in. discharge pipe from the upper basin passes through the length of the lower and is connected just outside the reservoir with a 20-in. supply main just inside the reservoir. The discharge pipe is provided with a T and gate so that water may be drawn through it from the lower basin. There is also a gate on the upper end of the pipe. A 20-in. discharge pipe extends through the wall of the lower basin ready for connection with a second supply main to the city.

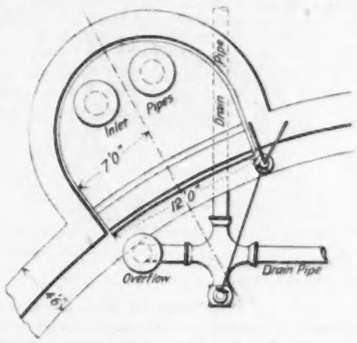


Fig. 4.

Fig. 2 shows a plan and section of the inlet chamber to the upper and Figs. 3 and 4 show the plan and section for the lower basin. The former is at a corner of the reservoir, and is semicircular at its outer extremity, the radius being 7 ft. There are two inlet pipes, turned upward, and hooded, as shown in Fig. 3. Water passes over a weir into the reservoir, the top of the weir being 5 ft. below the top of the reservoir coping. The inlet to the second chamber is similar in design, but the shape is different and but one inlet pipe is provided. This chamber is at the junction of the outer wall with that dividing the two basins.

A 14-in. drain pipe extends from the lower to the upper chamber, and from the latter through the reservoir wall. Connected with this pipe is an overflow at each chamber, while at each chamber a gate is provided by opening which the corresponding basin may be emptied.

We are indebted to Dunham & Paine, of New York City, engineers for the reservoir, for the information and drawings given. Mr. William B. Chisholm, East Liverpool, O., was contractor.

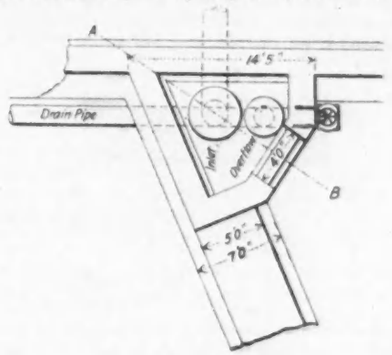


Fig. 3.

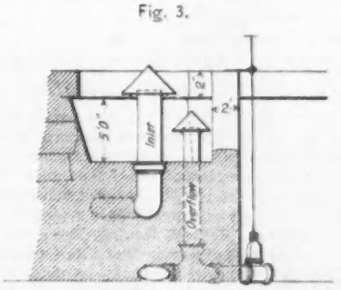


Fig. 2.

for the Baltimore & Ohio R. R., when oil lamps were generally more ornate than now, and the other two plants quite different. The estimate is also for a less amount of light:

Oil lamps	$203	Other items above not estimated.
Pintsch gas, in car.	228	
Pintsch gas, fixed.	150	
Carbureters	209	

The following comparative estimate is one put forward by the Frost Carbureter Co.:

6 double lamps	$210	Other items not estimated.
Pintsch gas, in car.	317	
Pintsch gas, fixed.	100	
Carbureters	207.25	

This last estimate actually allows $105 for half the number of oil lamps, but the estimate is doubled to make it correspond in number of lights with the other tables.

INCREASE OF THE USE OF ELECTRIC LIGHTS IN PARIS.

The total amount of gas supplied to 233,000 consumers in Paris was estimated at 10,870,000,000 cu. ft. for the year 1890, which means an average of 46,600 cu. ft. for one consumer, while in 1880 an amount of 8,600,000,000 cu. ft. was furnished to 148,514 consumers or an average of 57,962 cu. ft. each. Therefore the "Schweizerische Bauzeitung" computes that the gas consumption for that term increased 29%, and number of consumers 58%, while the average amount furnished decreased 19.5%. Of electric lights 2,700 arc lights and 37,000 incandescent lamps were used in Paris for the year 1888, against of 6,500 arc lights and 100,000 incandescent lamps in 1890, showing an increase of 140% of the former and 170% of the latter.

The consumption of petroleum in France in 1880 amounted to 38,930 tons, against 84,101 tons in 1890, an increase of 47%. Comparing the figures denoting the respective increase we have gas 26%, petroleum 47%, and 140% to 170% for electric light. Considering the very small number of electric lights in use in Paris in 1880, however, this shows slow progress.

Assuming each 16-c. p. incandescent light to be equivalent to a gas burner burning 5 cu. ft. per hour, and assuming each light to burn four hours per day for 365 days per year, 100,000 incandescent lights displace 730,000,000 cu. ft. of gas yearly, or about ¾ of 1% only of the present gas consumption. The 6,500 arc lights, however [Eng. News, Dec. 19, 1891], will represent nearly 1,000 c. p. each, or just about five times the total amount of light from the 100,000 incandescent lamps.

The comparative economy of high and low speed engines in furnishing power for an electric street railway has been tested by Mr. Chas. W. Wason, of Cleveland, O. The high speed plant consisted of six Armington & Sims engines, three 14½ × 15 ins. and three 18½ × 18 ins., belted to Edison dynamos. The low speed plant consisted two 28 × 48 ins. Corliss engines, built by C. & D. Cooper & Co., belted to a countershaft 7 ins. diameter and 80 ft. long. Four Edison dynamos were driven by belts from this countershaft. Each plant was given a ten-hour test, taking steam from the same boilers and furnishing electricity to the same line wires. The principal results were as follows:

	High speed engines.	Low speed engines.
Ave. E. HP. developed	563	630
Water evap. per lb. of coal per hour, lbs.	6.61	6.54
Coal used per ave. E. HP. per hour, lbs.	6.55	5.76
Combustible " " "	5.68	5.00
Coal used per car mile, lbs.	6.57	6.38
Ave. HP. per car	6.86	7.59

The new four-mile lake tunnel, at Chicago, has been examined by experts and their report has been submitted to Council. This report says in substance, according to the press, that 1,345 ft. out from the shore is in a fair condition, though the brick work is not according to the contract. About 6,000 ft. from the entrance the water percolates through and the brick arch has sunk in places as much as 8 ins. A more thorough investigation is recommended.

Steel ties (or sleepers) will form a part of the exhibit to be made at the World's Columbian Exposition by the Forestry Division of the U. S. Department of Agriculture, and Mr. B. E. Fernow is inviting models and specimens of steel ties in actual service on railways in this country and abroad.

THE MEMPHIS BRIDGE.

In our issue of Feb. 27 we illustrated the condition of work on Nov. 29, 1891, of the railway bridge now being built across the Mississippi River at Memphis, Tenn., showing the completed 621 ft. span and the commencement of the two cantilever spans of 621 ft. and 790 ft. We now give a view showing the condition of the 790 ft. span at 3 p. m., March 1, 1892. The cantilever arms are 169 ft. 4½ ins. long, and the central span 451 ft. 8 ins. The bridge will consist of one span of 790 ft. 5 ins., and two spans of 621 ft.

MEMPHIS BRIDGE; Geo. S. Morison, Engineer.
(Sketch showing condition of work on March 1, 1892.)

In a later issue we shall publish full details of thi bridge. Mr. George S. Morison, M. Am. Soc. C. E., is the engineer.

AMERICAN LOCOMOTIVES AND THE BLOCK SYSTEM IN NEW SOUTH WALES.

In a recent speech at Sydney, New South Wales, Mr. Eddy, Chief Commissioner of Railways of that colony, gave some very interesting particulars of the satisfactory performance of the American locomotives introduced on the Government railways, of which we give an abstract from a report in the "Daily Telegraph," Sydney, Jan. 22. These engines were described in Engineering News, Jan. 10, 1891.

The Commissioners have, in addition to giving better security, lately introduced engines which could exert more power than any engines previously in use, so that later on they would be able to reduce the rates, and so assist in promoting the settlement of people inland and increase the wealth of the colony. One question was that of the Baldwin engines, the ten-wheel American engines. All kinds of stories were current as to mistakes in their design, and alterations of the line and so on, and it was well the facts should be known. The engines had no mis take in their design. They were fitted as they were intended to be in regard to their size, and the alterations made upon the lines had no bearing upon the Baldwin engines. Before the Baldwin engines were ordered the Commissioners found on making their inspection trips over the lines that through various mishaps the works were in many places out of gage, that in the maintenance or construction of the lines the rails had been shifted in towards the fixed structures, causing the original standards to be encroached upon. They had simply given orders for everything to be brought back to gage. When the Baldwin engines were ordered, as they were to be made to the maximum size, the Commissioners had directed that this work should be pushed on, and it was completed by their arrival. The necessity was put down to the new engines. There was an erroneous idea that the cost of this work had been something great, but the total expenditure had been: For altering the stations and platforms, $12,390; and for altering lines, $560; a total of $12,950 for the whole of the railways of the colony.

There was also an impression that these engines were not doing much work, but within a fortnight past had taken the Commissioners 1,600 miles, traveling at times at speeds up to 52 miles per hour, and behaving in a perfect manner. From a return he had had prepared he found the engines had run since they started an average of 10,000 miles each, equal to 23,000 miles per annum, and when it was remembered that the annual average of locomotives on the level lines of England was only 18,000 miles the merit of the performance could be seen. The new American freight engines had also run over 100,000 miles, making a total, with the passenger engines, of 220,000 miles since they had been put into service. The Commissioners made an experiment with the Western train with one of the passenger engines. Seven of the 46-ft. lavatory cars were put on and 190 passengers carried up the Blue Mountains, calling at every platform, which is unusual for a train to do, and, notwithstanding the load and the 1 in 30 and 1 in 33 grades, the train reached Katoomba 4 mins. in advance of schedule time, the load taken being in excess of what is usually taken by two engines. The only fault with the engines was that inferior material was supplied in the bogie (truck) axles. These axles, however, were being withdrawn and altered, and at the expense of the builders.

The Commissioners also introduced a new type of freight car called the "tubular frame" car, which has a tare, or dead weight, of 10 tons, and a carrying capacity of 22 tons. These had been working some months, and had carried 13,934 tons, the tare being 7,598 tons. Had the same weight been carried in ordinary cars the tare or dead weight would have been 12,572 tons, so that they had saved the haulage of 4,574 tons dead or non-paying weight. As a test of what the new freight engines could do, a few days ago one of them hauled a train of these tubular frame cars from Junee to Sydney up grades of 1 in 40. The weight behind the engine was 284 tons, of which 188 tons consisted of freight or paying weight. The engine hauled this well, which was twice as much work as the ordinary engines would do. With these machines, the Commissioners hope, by economy in working, to be able to bring the rates down, and so assist in the development of the country, and make the rates on produce, which are now lower than the rates in any of the other Australian colonies, lower still.

The record given is a really good one for an engine of this class, even in the best American practice, although in no way specially remarkable; and if this really was "twice as much work as the ordinary engine will do," they must have been very light or very inefficient. The specified load behind tender, 284 long tons, is equal to 318 tons of 2,000 lbs. The engine and tender, as previously described, weigh 101 net tons, 122 tons on drivers. The gross load hauled up a 2½% grade was therefore 419 tons. By referring to the large table 170 of "The Economic Theory of the Location of Railways" it will be seen that an engine with 48 tons on the drivers is credited with the power to haul "in daily service" 334 tons of cars, or 414 tons including its own weight, up a 2½% grade, which is equal to 422 tons gross weight of train for an engine with 48.8 tons on drivers, against 419 tons actually hauled in this reported instance. The table referred to is computed on the assumption of 0.25 ratio of adhesion and 8 lbs. per ton rolling friction.

The "tubular frame" cars are of the American pattern, carried on a pair of four-wheel diamond trucks, and were built in England by the Tubular Frame Wagon Co., of London. Mr. Eddy also stated that during the three years the Commissioners had been in office they had largely extended the block system.

They had increased the length of line worked under the block telegraph system from 23 to 441 miles, and a more secure system of working had been adopted on a further 600 miles. They hoped by next year to have the greater part of the railways of New South Wales worked under the absolute block system. The number of places interlocked had been increased from 104 to 250, the latter being a little over one-half of the places to be dealt with. The interlocking material which was imported from 1884 to 1888 cost $100,000, but after negotiations with the patentees the Commissioners secured the right to make the material, and since they have been in office they have spent $140,000 in the colony in this work. They also now obtain in the colony many articles that were formerly imported, including frogs and switches, headlights, lamps, etc. The length of double line has been increased from 71 to 130 miles, while 189 miles of line have been relaid and 475 miles had been re-ballasted.

Referring to the ambulance corps of the railway service, W. Eddy stated that there were then 434 members enrolled and 70 candidates waiting examination, so that at an early date the ambulance corps could be expected to be 500 strong. The Commissioners anticipated that out of the total number of 13,000 employees more would join the corps annually, and the Commissioners would be glad to encourage the movement in every way. Every train running beyond the suburban area is fitted with an ambulance chest and every possible requirement in case of an accident happening. There are 14 stations fitted with the ambulance appliances, and so are all the wrecking cars, and the ambulance corps works in connection with them.

A PORTABLE FLUSH GATE FOR SEWERS.

A device for flushing sewers having a light grade, and which may be used with or without the use of water from the city water-works system, has recently been perfected and patented by Mr. E. E. Fitzpatrick, sewer inspector at Wichita, Kan.

As will be seen from the illustrations, the flush gate is very simple in construction and operation, it being easily worked by one man. It consists of a circular "dam-head," preferably of hard wood, the inventor says, of original diameter slightly larger than the sewer to be flushed, and with its outer edge beveled so that the shield will enter the sewer. A rubber gasket is used to insure tightness. The head is held in place by a jointed rod provided with a turn-buckle (see Fig. 1), with right and left screw

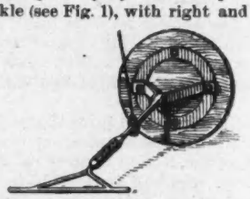


Fig. 1. View of Flush Gate.

threads, to admit of lengthening or shortening the rod. The rod divides in two parts at the end furthest from the dam-head, and connects with another rod at right angles to the main rod, designed to extend across the mouth of the sewer at the side of the manhole opposite the dam head, as shown in Fig. 2. There is a joint in the rod at its connection with the head and another near its middle. A clevis and rope connect the latter joint with the surface, and by means of these the joint is tripped when desired, as in Fig. 3.

After locating obstructions or deciding upon sections of a sewer to be cleaned the device is lowered into a manhole, the head placed at the mouth of the sewer where the sewage is to be backed, then

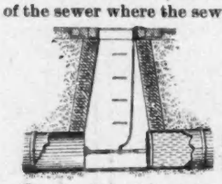


Fig. 2. Gate Adjusted.

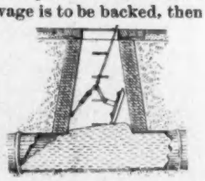


Fig. 3. Gate Lifted

braced by arranging the rods already described. Once in position the operator can leave the flush gate and inspect laterals through observation holes. When the sewage or flush water, or both, have set back far enough the gate is tripped by means of the rope running from the clevis and joint to the surface. The water having slowly backed up in the main and laterals has loosened deposits above the gate. When the water which has been held back rushes down the main below the gate of course the latter is thoroughly flushed. While the flush gate has been stopping the natural flow in the sewer the main and laterals below have had an unusual chance to clear themselves.

It is evident that the gate can be used to shut off the flow from any section of a main if so desired for any purpose.

The device has been approved by Mr. O. Mulvey, City Engineer of Wichita, and has been adopted by the Wichita City Council for use in that city, gates having been ordered for 20, 18, 12, 10 and 8-in. sewers.

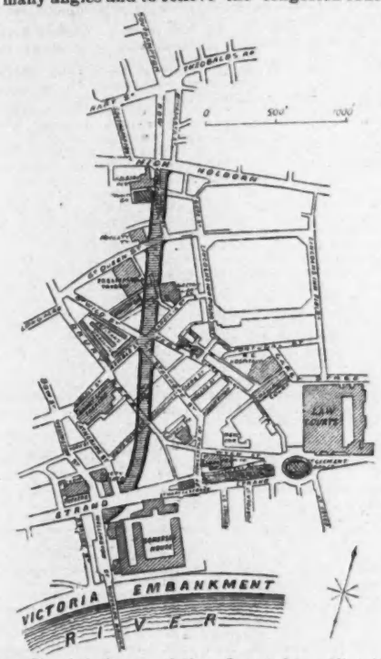
Proposals will be received shortly by Mr. D. H. Burnham, Chief of Construction, World's Columbian Exposition, for the construction of the sewage disposal plant, for laying pipe from the pumping station to the fountains, and for laying pipe for the transmission of power by compressed air.

A new post office building at Chicago is proposed by Mr. W. J. Edbrooke, Supervising Architect, U. S. Treasury Department, and a bill to authorize its construction is to be introduced in Congress this session. The building is to be located on the lake front, with railway connections for running mail cars into it, and will also have accommodations for the U. S. Courts. The bill appropriates $4,000,000 for this work, and it is expected the present building and site can be sold for $5,500,000.

A PROPOSED NEW STREET IN LONDON.

For the benefit of some American citizens who object to interfering with the gridiron street formation of their ancestors and to diagonal streets as a means of improved communication, we give the following map of improvement recommended by the County Council of London:

The purpose of the new street, which would be 90 ft. wide, is to open up a direct thoroughfare from the north to the south of London, avoid the turning of many angles and to relieve the congested routes



Plan Showing Proposed New Street from High Holborn to the Strand, London.

now followed by this traffic. The new street would be about 2,300 ft. long, starting on Little Queen St. and High Holborn and entering the Strand at Wellington St. and the outlet over Waterloo Bridge. The cost of the scheme is estimated at about $3,000,000, and as a broad, direct and handsome avenue would be substituted for a tangle of narrow and uninviting streets, the return for this outlay, in increased values and taxes, is very apparent. The same thing can be done with profit in many of our older American cities, and especially by cutting a generous avenue diagonally across the common rectilinear street formation.

REDUCTION OF PUMPING EXPENSES AT CINCINNATI, O.

A great saving in operating the Front St. pumping plant of the Cincinnati water-works has been effected in the past year by the introduction of new boilers, the addition of feed water heaters and the mechanical handling of coal. March 5, 1891, the city contracted with the Sterling Co., Barberton, O., for a 1,200-HP. plant of water tube boilers. This type, although said to be shorter lived than others, was selected because the space for the plant was limited and these boilers would occupy not more than one-half that taken by the ordinary type of cylindrical boilers. In addition the plant cost but $17,100, against $27,000 for cylindrical boilers. The new plant takes the place of 31 boilers from 4 to 30 years old which had been forced beyond their rated capacity and were in such a condition that it was considered dangerous to carry more than 115 lbs. of steam pressure. Besides this, before the improvements were made feed water was delivered to the boilers at a low temperature and after having been pumped to a reservoir at an excessive cost, owing to defective pumping machinery. And still further, the smoke from the old plant was a great nuisance, which has now been practically abolished, although an inferior quality of coal is now used.

The economy of the new plant is well shown from the following figures: The average daily cost of pumping 32,500,000 gallons last July, with the old plant, was $338, which has been about the average for several years past. Of this amount $72 was for labor and $286 for coal. With the new plant the average daily expense for pumping the same quantity of water, 32,500,000 gallons, is $248, of which $48 is for labor and $200 for coal. The daily saving, as indicated by the above figures, is $109, and the yearly saving, $39,840. In addition, water from the hot well, which was formerly wasted, is now used for the boilers instead of being drawn from the reservoir, after having been pumped, as formerly. This, of course, effects quite a saving.

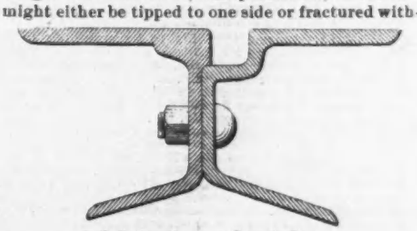
The feed water, it should be stated, was formerly delivered to the boilers at a temperature of 58°, while at present it is delivered at 197°, it leaving the hot well at 117°, and being raised to 197° in a heater operated by waste steam.

With the old plant 117⅕ tons of lump coal were used daily; with the new plant 38 tons of lump and 53 tons of slack coal are used.

The above information is compiled from a report to the Cincinnati Board of Administration by Willis T. Sharp, Superintendent and Engineer of the water-works.

A GERMAN TRAMWAY RAIL FOR PROTECTION OF PAVING.

This rail, illustrated in the "Zeitschrift fuer Transportwesen und Strassenbau," from which we abstract this note, is to be constructed in two parts; and the top flanges are made exceptionally wide so as to give a wide track for ordinary vehicles, in order to prevent the formation of ruts on each side of the rails, which has proved so detrimental to the paving when the ordinary narrow rails are used. The foot and sides of this rail are to be imbedded in concrete. The tamping under the top flanges has to be done with special care, as the rail might either be tipped to one side or fractured without such solid bearing. We should judge that the rail was primarily intended for use on streets which already have a concrete foundation for paving.



A Rail for Use on Paved Streets.

A VERTICAL BOILER WITH PROTECTED TOP FLUE SHEET.

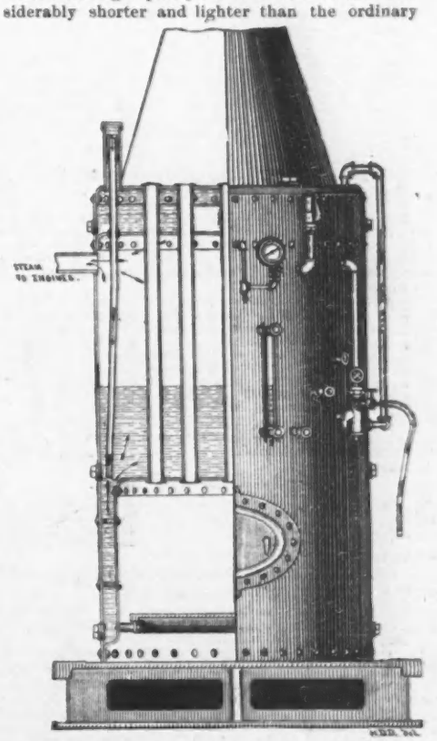
An improved type of vertical boiler, which has been in use for some time on steam fire-engines, is being introduced for use with hoisting engines by the American Hoist & Derrick Co., of St. Paul.

Ordinary vertical boilers, especially those of small size in which the tubes are necessarily short, are apt to give trouble by leaking around the tube ends in the upper tube sheet, which not being exposed to the water will get very hot whenever the boiler is forced. To increase the durability of this sheet the submerged-flue type of boiler, in which the upper tube sheet is of the same diameter as the lower and is depressed below the water level, has been considerably used. Boilers of this type will not burn out their tube sheets; but on the other hand they have so small a steam space and so contracted a passage for the movement of the steam up past the upper tube sheet that they are apt to furnish wet steam when hard worked and will send more or less water over into the cylinders.

The boiler which we illustrate in the accompanying cut has the upper tube sheet at all times in contact with water, and yet will work hard without foaming. It will be seen that a partition extends across the boiler a short distance below the upper tube sheet, and this upper chamber (K) is at all times kept full of water, the feed pipe (C) emptying directly into it. The heating surface of this chamber is so proportioned that it acts as a feed water heater, and brings the water to the full boiler temperature. The overflow rises in the chamber (E) and passes down through the vertical pipe (F) into the main compartment of the boiler. It will be seen that even when the feed is stopped and steam begins to form in the upper chamber that it will remain practically full of water, for the steam will rise in the stand-pipe E, and will flow down the pipe F.

By heating the water to full boiler temperature most of the sediment and scale is deposited on the sheet which forms the floor of the chamber K. It can do no harm here, as this sheet is not exposed to the fire; and as it is not burned on, it can be readily washed off. By this means the crown sheet and firebox are protected from scale.

Among other points of interest it will be noted that the boiler has unusually large steam room, thus insuring dry steam. The fact that it has been successfully applied to fire engines for some years by the Watrous Engine Works, of St. Paul, proves its good qualities in this respect. At a fire in Duluth, Minn., last fall, a fire engine with a boiler of this type began working Nov. 11, at 9 a. m., and worked continuously for 90 hours without shutting down. As might be supposed from its use on fire engines, steam can be raised very quickly with this boiler, 100 lbs. pressure has been secured from cold water in 15 minutes on a hoisting engine. For ordinary sizes the extra cost of this style boiler over an ordinary boiler of the same size is $40 net. For the same steaming capacity the boiler can be built considerably shorter and lighter than the ordinary vertical boiler, making it easier to handle and saving considerably in freight shipments, an important matter to a contractor whose working plant is frequently on the move.



A Vertical Boiler With Protected Top Flue Sheet.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

INDIANA, ILLINOIS & IOWA.—Local papers state that this company has secured the money necessary to build the proposed line from Knox to South Bend Ind., 40 miles, and that construction will begin as soon as the weather will permit.

WABASH.—It is stated that B. F. Johnson & Co., who have the contract for building the line from Montpelier, O., to Hammond, Ind., about 143 miles, have sublet the contract, and that work will soon be in progress along the entire line.

LAKE HOPATCONG, BOONTON, MORRISTOWN & NEW YORK.—The surveys for this proposed railway from Caldwell to Rockaway, N. J., 47 miles, with a branch to Morristown, 7 miles, have been completed. Ch. Engr., C. C. Vermeule, 71 Broadway, New York City.

PITTSBURG, AKRON & WESTERN.—At a recent meeting of the directors of the Akron & Eastern R. R. Co., whose incorporation was noted last week, the following officers were elected: Pres., W. A. Lynch; V.-P., D. E. Hill; Sec., C. W. Risley; Treas., F. M. Semple, and Ch. Engr., J. H. Semple.

BOSTON & MAINE.—It is stated that this company will at once begin work on a grain elevator of 1,000,000 bushels capacity, which is to be erected on the Old Eastern R. R. wharf in East Boston.

BALTIMORE & OHIO.—This company's proposed new terminal bill has been introduced into the Maryland Legislature. A press dispatch says: It empowers a corporation known as the Baltimore Forwarding Co. to connect its tracks with those of other companies in Harford and Baltimore counties, and to purchase the right of way to the docks and wharves of Baltimore. The stock in this company is all held by the Baltimore & Lehigh R. R. Co., in which the Baltimore & Ohio, the Lehigh Valley and the Reading are large stockholders. The bill, if passed, will enable the Baltimore & Ohio to have terminals on both sides of the harbor and a station in the heart of the city, like the Pennsylvania's station in Philadelphia. An officer of the Belt Line Tunnel Co. says that two stations for the use of the Baltimore & Ohio, the Reading and the Baltimore & Lehigh roads, will be erected at a cost of $1,000,000, one to be in the northern part of the city, near the Pennsylvania's station and the other in the center of the business portion.

Projects and Surveys.

NEW YORK, PHILADELPHIA & CHICAGO.—The officers of this company state that work is in progress looking toward the construction of the line. The route of the road is as follows: Beginning at Franklin, in Venango Co., thence down the west bank of the Allegheny River about six miles, there crossing over to the mouth of East Sandy Creek, thence up East Sandy Creek, passing through the Clarion oil field, crossing the Clarion River at Clarion, thence through the rich agricultural, lumber and coal districts of Clarion Co. to Corsica, in the western edge of Jefferson Co., thence passing through a rich agricultural and mineral region to Brookville, the county seat of Jefferson Co., thence through the rich lumber and coal region lying east of Brookville, crossing the line of Jefferson Co. into Clearfield Co. near Falls Creek, where connection may be made with the Low Grade division of the Allegheny Valley, the Buffalo, Rochester & Pittsburg, Ridgeway & Clearfield, and the Reynoldsville & Falls Creek railways, thereby being able to reach the coal deposits in that section. Leaving Falls Creek, the line follows up the Sandy Lick Creek valley, passing through the town of Du Bois, thence continuing up the Sandy Lick valley through the large pine timber and coal tracts of that section, to the village of Brocton. From Brocton the line follows down Anderson Creek to Curwensville on the west branch of the Susquehanna River, and thence down to Clearfield, the eastern terminus, a distance of 108 miles from Franklin.

SOUTHBRIDGE, STURBRIDGE & BROOKFIELD.—The town of Southbridge, Mass., has voted $18,500 in aid of this proposed railway from Brookfield to Sturbridge, Mass., 13 miles. Ch. Engr., Arthur C. Moore, Sturbridge.

KITNER, ELBON & SHAWMUT.—Chartered in Pennsylvania to build a railway from Oyster, Horton Township, Elk Co., to a point on the Glen Hazel & Shawmat R. R., in Jones Township, Elk Co., 28 miles. Pres., B. E. Cartwright, Ridgeway, Pa.

MICHIGAN.—A project is on foot to build a railway across the Northern Peninsula of Michigan connecting Lake Superior and Lake Michigan. The route will be from a point in the vicinity of Deer Point to Newberry, where the headquarters of the company will be located, and thence southeast through Mackinac and Schoolcraft counties to a harbor near Point Seulchoix, about 20 miles east of Manistique, Mich. Among those interested are: M. W. O'Brien and E. W. Cottrell, of Detroit, Mich.

WILKESBARRE & EASTERN.—Chartered in Pennsylvania to build a railway from Wilkesbarre, Pa., to near the Delaware Water Gap. Pres., W. P. Ryman, Wilkesbarre, Pa.

Southern.—Existing Roads.

OHIO VALLEY.—About four miles of the 11-mile extension from Gracey's to Hopkinsville, Ky., have been graded. It is expected to have the remaining seven miles graded by June 1 and the line completed by July 1. There will be four 100-ft. span iron bridges.

CHARLESTON, CLENDENNIN & SUTTON.—Work on the first 30-mile section of this line, contracts for which have been let as noted last week, will begin in a few days. The road is to be single track, and will be laid with 56-lb. rails. C. K. McDermott, of Charleston, W. Va., is the engineer in charge of work.

RICHMOND, NICHOLASVILLE, IRVINE & BEATTYVILLE.—The bridge at Irvine, Ky., has been completed, and work will now be rapidly pushed on the extension to Beattyville, Ky.

CHESAPEAKE & OHIO.—Under the authority granted by the stockholders at a recent meeting, a general mortgage deed on all of the company's property has been recorded with the Central Trust Co., of New York City, and Henry T. Wickham, of Hanover Co., Va., as trustees. The mortgage is to secure the payment of $70,000,000 bonds issued for the general uses of the corporation, and additional bonds not to average over $25,000 per mile for the purpose of double tracking the company's system.

OXFORD & COAST LINE.—Grading has been begun on the 14-mile section of this line from Oxford, N. C., to the Durham & Northern R. R., by contr., J. T. Pruden, of Oxford, N. C. The road will be operated by the Seaboard Air Line system after completion. Pres., W. F. Beasley. Ch. Engr., Ashton A. Chapman, both of Oxford, N. C.

Projects and Surveys.

GURLEY'S & PAINT ROCK VALLEY.—The preliminary survey has been begun for this proposed railway from Winchester to Deposit, Ala., 70 miles. Pres., F. B. Gurley, Gurley's, Ala.; Ch. Engr., S. I. Wheatcroft. Asst. Engr., W. H. Calhoun.

PICKENS.—It is stated that engineers are now locating this proposed railway from Easley to Pickens, S. C., 9 miles, and that construction will begin at once. The contractor is J. H. Burkhalter, of Augusta, Ga.

CHICAGO, EVANSVILLE & CHATTANOOGA.—The contract for building the section of this proposed road from Evansville, Ind., to Bowling Green, Ky., about 100 miles, is reported let to Oliver Ferguson & Son. The road is projected to run from Evansville, Ind., to Chattanooga, Tenn., 225 miles. Ch. Engr., A. B. Fitch, Terre Haute, Ind.

NORFOLK, WILMINGTON & CHARLESTON.—Chambers H. McKibbin, Gen. Man., 212 South Third St., Philadelphia, Pa., writes us that this road will be 600 miles long including branches. The main line from Norfolk, Va., to Charleston, S. C., has been surveyed and a very favorable line secured. There will be no heavy grading; the average being about 7,000 cu. yds. per mile. The line will cross the Neuse, Roanoke, Peedee and Santee rivers. The principal business of the road will be in lumber, turpentine, resin, cotton, fertilizers and general merchandise. It is expected to let the contracts for building the line sometime between July 30 and Sept. 30, 1892. Pres., R. Duncan Harris; Ch. Engr., John Runk.

BEAVER LICK.—Chartered in West Virginia to build a railway from Davis, Tucker Co., W. Va., to a connection with the West Virginia Central & Pittsburg R. R. Among the incorporators are: D. C. W. Smith, of Maryland, and Henry L. Carter and H. W. Stokes, of Philadelphia, Pa.

COAL RIVER VALLEY.—Chartered in West Virginia to build a railway from St. Albans, W. Va., to a connection with the Norfolk & Western R. R., at Oceana, W. Va. The principal office will be at Charleston, W. Va. Among the incorporators are: Samuel Fulton, of Philadelphia, Pa., and Andrew Meyer, Brooklyn, N. Y.

BLUE RIDGE SPRINGS & FINCASTLE.—This company proposes to build a railway connecting the Norfolk & Western and the Roanoke, Fincastle & Clifton Forge railways. A bill is now before the Virginia Legislature granting it a charter.

VIRGINIA.—Bills have been introduced into the Virginia State Legislature incorporating the Southern R. R. & Loan Co., and the Bristol & Northern R. R. Co.

Northwest.—Existing Roads.

CANADIAN PACIFIC.—The people along the route are endeavoring to secure the extension of the Stonewall Branch from Stonewall, Man., about 20 miles north into the Belmoral district.

BURLINGTON & MISSOURI RIVER.—This company has let the contract for building a branch from Englewood, S. Dak., through the Bald Mt. and Ruby Basin mining districts to Spear Fish, S. Dak., 25 miles, to Kilpatrick Bros. & Collins. Work will be commenced with a force of from 2,000 to 5,000 men within ten days.

Projects and Surveys.

CHICAGO, ALTON & PADUCAH.—Chartered in Illinois to build a railway from Altamont, Effingham Co., Ill., to Paducah, Ky. Among the incorporators are: Pidello Smith, Clinton, O.; Walker G. Cowan, Charterri, Pa., and J. B. Messick, East St. Louis, Ill.

RED RIVER VALLEY.—Chartered in North Dakota to build a line of railway. The officers are: Pres. E. R. Jacobis, Grand Forks, N. Dak.; V-P., J. C. Hall; Treas. F. W. Peterson, and Sec., T. A. Sullivan, East Grand Forks.

CHICAGO, LAKE GENEVA & NORTHWESTERN.—This company, whose incorporation in Illinois was noted in our issue of Feb. 20, has been chartered in Wisconsin. The two charters authorize the construction of a railway from Chicago, Ill., to Madison, Wis. Among those interested are: De Clermont Duniap, Rockford, Ill., and J. S. Monk, and F. C. Elliott of Chicago.

CANADA.—Among the bills to be presented to the Dominion Parliament for railway charters and amendments are the following affecting Manitoba and the western provinces: Alberta Ry. & Coal Co., to construct a railway west through the Crow's Nest Pass to some point on the Canadian Pacific Ry. in British Columbia. British Columbia Southern Ry. Co., incorporated by local Legislature, for act to give company a Dominion charter and to authorize the extension of the railway from its eastern terminus in the Crow's Nest Pass, east to a point on the line of the Calgary & Edmonton Ry., and thence to connect with the same, with power to continue such extension to the towns of Macleod and Lethbridge, in the district of Alberta. Columbia River to Kootenay, for incorporation of company to construct a railway from some point on the Columbia River near the southern boundary of British Columbia to Kootenay Lake, at or near the town of Nelson via Salmon River and Cottonwood-Smith Creek. Columbia River to Kootenay, for incorporation of a company to construct a railway from the southern boundary of British Columbia, at a point on the Columbia River, thence along the valley of the Columbia River to some point at the mouth of the Kootenay River, near the town of Robson. Grand Trunk Ry., for authority to deviate certain parts of their line known as the Northern & Pacific Junction Ry.; also to extend the said line to a junction with the Canadian Pacific Ry. at North Bay, Lake Manitoba Ry. & Canal Co., for amendment to charter extending the times limited for the commencement and completion of the railway and canal works. Manitoba & Southeastern Ry. Co., for amendment to charter by extending the time for the construction of the company's line of railway for two years. Manitoba & Northwestern Ry. Co., for an act to amend and consolidate the different acts relating to the company, and to increase its borrowing powers. Manitoba & James Bay Ry., for an act to incorporate a company to construct and operate a railway from Winnipeg, or from Eagle River on the Canadian Pacific Ry., or from some point on the Canadian Pacific Ry. between Winnipeg and Port Arthur, northeast or northwest, as the case may be, to a point on the Albany River, at the head of the navigable water of that river. Manitoba & Assiniboia Grand Junction Ry. Co., for amendment to charter granting the company power to extend its line from a point at or near Lake Dauphin to and into the city of Winnipeg, and to issue preference shares in addition to ordinary share capital. Nipissing & James' Bay Ry. Co., for amendment to charter extending the times limited for the commencement and completion of the several sections of the road, for the alteration of the point of commencement and for power to increase the issue of bonds to a sum not exceeding $25,000 per mile. Nicola, Kamloops & Similkameen Coal & Ry. Co., for an act to incorporate a company to build and operate a railway from a point at or near Spence's bridge, British Columbia, through Nicola valley to the town of Princeton; thence to Osoyoos Lake, and to Fort Sheppard; also from the Nicola valley in a northerly direction to the town of Kamloops, and also to a point at or near Hope and thence to Chilliwack. Nicola Valley Ry. Co., incorporated by the local Legislature of British Columbia, for an act to give the company a Dominion charter, and for power to extend, construct and operate its line of railway. Qu'Appelle, Long Lake & Saskatchewan Ry. & Steamboat Co. for an extension of the time for the completion of the undertaking. Sault Ste. Marie & Hudson Bay Ry. Co. for an extension of time for the commencement and completion of railway. Wolseley & Fort Qu'Appelle Co., for incorporation for the purpose of building a railway from a point on Canadian Pacific Ry. at or near Wolseley, thence to the Qu'Appelle Valley via Wolf Creek, and up that valley to Fort Qu'Appelle, a distance of about 40 miles. Wood Mountain & Qu'Appelle Ry. Co., for extension of time for commencement and completion of road. Winnipeg & North Pacific Ry. Co., for amendment to charter authorizing the company to construct its line from a point on the proposed line of the Winnipeg & Hudson Bay Ry. west of Lake Winnipegosis, thence westerly to Prince Albert, and thence according to the original act of incorporation; confirming agreement with the Winnipeg & Hudson Bay Ry. Co., and extending the time for the construction of the road.

Southwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—The Minco, I. T., "Minstrel," for Feb. 15, contains the following information in regard to the progress of work on the line between that point and Henrietta, Tex.: "The Rock Island is now booked to reach Red River inside of three months. All the road between Minco and Red River has been established, and the contracts for grading have been signed for the entire distance. The first section of 19 miles is now nearly finished, and one of the contractors has gone on beyond and is throwing dirt among the hills on the south side of the Little Washita, about 30 miles from here. The track on the first 19 miles will shortly be laid and material taken from here to build further on. Men and teams are being employed wherever they can be used and the earth is being ripped up at a rapid rate. It is the calculation to cross Red River into Texas by June 1. Across the river will be built an iron bridge on stone piers, and work on the piers will begin now in a little while so as to have the work ready for the bridge iron as soon as the road can carry it over the track. Grading between here and Red River is let to six contractors, three more than are now at work."

AUSTIN & NORTHWESTERN.—A press dispatch from Fairland, Tex., says: "The first car load of iron for the railroad bridge over the Colorado on the Llano extension has arrived. Steel rails for several miles of the road are now here, and half a mile of the track laid at the "Y" junction with the main track. The ties will be all sawed and 15,000 or 20,000 are already here. In a day or two tracklaying will begin and will be pushed on to the Colorado River in a few days, as the work of putting in piling in the small openings is progressing fast. The last mile of the grade has been subcontracted and work is going on on nearly every mile of the grade. As soon as the track is laid to the river, ten miles, to land the bridge material, work on the bridge will begin with a large force. Everything indicates an early completion of the road."

ATCHISON, TOPEKA & SANTA FE.—It is rumored that this company has under consideration the construction of a line from Paul's Valley, Ind. Ter., to Wichita Falls, Tex., about 90 miles.

Projects and Surveys.

KANSAS CITY, ARKANSAS & NEW ORLEANS.—The "Manufacturer's Record" says: "Curtis G. Stoddart, of 18 Broadway, New York City, is President; Merritt H. Johnson, Vice-President, and T. F. Singiser, Secretary, of the Kansas City, Arkansas & New Orleans R. R. Co., lately reported as to issue $6,000,000 of bonds for construction purposes. The route of the proposed road is from Chadwick, Mo., via Forsyth, Mo., Yellville, Marshall, Clinton, Beebe, Hazen, Stuttgart, Monticello and Hamburgh to a connection with the Houston Central, Arkansas & Northern R. R. at a point near Bastrop, La. The line is graded ready for ties and rails from Hazen for a distance of 45 miles to a point 23 miles south of Stuttgart, Ark. The company has offices at Beebe, Little Rock, 18 Broadway, New York City, and Bartholomew House, London, England. The capital stock is $6,000,000."

AUSTIN, FREDERICKSBURG & LLANO.—Chartered in Texas to build a line of railway from Austin, Tex., to Dripping Springs, Hayes Co., Tex. Among the incorporators are: G. Beckers, San Antonio, Tex.; Chas. P. Scrivner, of Austin, Tex., and J. W. Hoyt, of New York City.

QUANAH & OKLAHOMA.—This company, previously noted as applying to the Federal Government for right of way through the Indian Territory, has filed articles of incorporation with the territorial secretary. It proposes to build a railway from a point on the Fort Worth & Denver City Ry., in Texas, north through the Indian Territory to the Kansas State line. Among the incorporators are: S. P. Khoot, Quanah, Tex.; J. S. Clarkson, Des Moines, Ia., and M. Jones, Ft. Worth, Tex.

Rocky Mountain and Pacific.—Existing Roads.

DENVER, LAKEWOOD & GOLDEN.—In a recent interview President Samuel Newhouse said: "We will go right ahead now and push the work of building the road into Denver from its present terminus on the West Side. This work and the Villa Park Branch will be completed by April 1, and the Lookout Mountain line will not be very far behind them. A branch will also be constructed to the mines of the Denver Coal Co. on Ralston Creek, and is expected to be in running order in a very short time. The financial condition of the company is the very best, and we have all the money we want. Work will no longer be delayed, notwithstanding some objections which may be made by some of the stockholders who are dissatisfied. The Pullman Company in Chicago are constructing the new rolling stock, which will be as fine as they are able to turn out. The electric equipment will be the very best it is possible to get."

RIO GRANDE SOUTHERN.—Ch. Engr. C. W. Gibbs is making surveys for a branch from Hesperus, Colo., to coal fields in the vicinity.

COLORADO MIDLAND.—The route of the branch to the Cripple Creek mineral lands in Colorado has been definitely decided upon. The branch will leave the main line at Hayden's, and will be 12 miles long. The maximum grade will be 2%. It is thought that the contract will be let to Lantry Bros., and that work will be begun at an early date.

LOS ANGELES TERMINAL.—The preliminary surveys for the proposed line from Los Angeles to Hueneme, Cal., will, it is stated, soon be commenced. There are some prospects that construction may be begun in the near future.

Projects and Surveys.

SALT LAKE, COLORADO & GULF.—A correspondent writes that surveys have been completed for this line for 200 miles. It will be a standard gage road for passenger and freight traffic, and will open up fine coal fields. J. V. Hannah, Denver, Col., or H. B. Ferguson, Albuquerque, N. M., can furnish information.

ZUNI MOUNTAIN.—A correspondent informs us that surveys have been completed for this railway for about 150 miles, and construction work on the first 100 miles is to be commenced in the spring. The rails have been purchased and the ties are now being secured. It will extend from Mitchell, N. Mex., a point on the Atlantic & Pacific R. R., 125 miles west of Albuquerque, N. Mex., south to Valencia Co. It is projected to develop the timber and coal interests in this section. It will be a 3 ft. gage, with maximum grades of 3½%, and maximum curve

of 30 deg. Samuel M. Rowe, M. Am. Soc. C. E., Chicago, Ill., is the Chief Engineer.

ANACONDA & BITTER ROOT VALLEY.—Covey Bros., of Ogden, Utah, are reported to have the contract for this railway from Anaconda to Hamilton, Mont., in the Bitter Root Valley, 70 miles long.

EUREKA & RED BLUFF.—It is stated that the people along the route are endeavoring to secure the construction of a railway from Eureka to Red Bluff, Cal. Marcus Pollasky is interested.

ELECTRIC RAILWAYS.

BUFFALO, N. Y.—The Buffalo, Bellevue & Lancaster Ry. Co. has been incorporated by H. W. Box, John L. Williams and J. C. Conway, with a capital stock of $20,000.

CARBONDALE, PA.—The Carbondale Traction Co has been incorporated to build an electric road to Simpson. Capital stock, $100,000. Pres., John W. Aiken.

BALTIMORE, MD.—The Central Ry. Co. will rebuild its 12 miles of track and equip it for electric traction. The company's engineer is J. L. Blackwell.

PORTSMOUTH, O.—Proposals for building and operating an electric road will be received by S. G. McCulloch, City Clerk.

WAUKEGAN, ILL.—The Waukegan & North Shore Rapid Transit Co. proposes to build 7 miles of electric railway. Pres., Dunlap Smith, Chicago; Secy., Homer Cook, Waukegan.

EAST ST. LOUIS, ILL.—The Columbian Underground Electric Traction Co. has been incorporated by D. J. Murnane, George L. Van Beek and S. Van Puhl. Capital stock, $1,000,000.

STOCKTON, CAL.—The Thomson-Houston Co. has a contract for the equipment of 5½ miles of trolley line. The wires are to be 20 ft. above the street.

CABLE RAILWAY.

NEW YORK, N. Y.—The Metropolitan Traction Co. will adopt the cable system on the 6th Ave. surface road, which it has leased.

HORSE RAILWAYS.

MONTCLAIR, N. J.—The Montclair & East Orange Ry. Co., with a capital stock of $25,000, has been organized by M. L. King, G. De Lole Zimmerman, of East Orange, and T. Nevins and J. O. Ward, of Orange. The line will be two miles long.

CARROLLTON, MO.—The Carrollton Street Ry. Co. has been incorporated by Alfred Hassick, D. D. Thomas and H. S. Jewell. Capital stock, $10,000.

HIGHWAYS.

PENNSYLVANIA.—The taxpayers of Abington township will vote on the issue of $240,000 of road improvement bonds. The authorities of East Goshen township borrow $30,000 for road improvements.

OHIO.—The County Commissioners of Belmont County will apply to the legislature for power to appropriate an additional sum of $30,000 to complete the roads. There are 22 miles, and it is estimated that this sum will allow of 600 yds. of stone per mile being put on. The Senate has passed a law authorizing the commissioners of Franklin County to issue $20,000 in bonds for road improvement.

BRIDGES, TUNNELS AND CANALS.

NEW BRUNSWICK, N. J.—The Board of Freeholders of Middlesex Co., N. J., have voted to build a stone arch bridge across the Raritan River at the foot of Albany St. The structure will cost about $100,000, and the plan of Dean & Westbrook, of New York City, has been accepted.

BALTIMORE, MD.—It has been decided by the City Councils Committee to build the bridge over Jones Falls of stone. The estimated cost of the structure is $381,000.

WASHINGTON, D. C.—Bids will be received until March 30 for building a steel plate girder highway bridge over James Creek Canal at K St.

PITTSBURG, PA.—The directors of the South Tenth St. Bridge Co., operating a wooden bridge from Pittsburg to the South Side, will replace the present structure with a suspension bridge, to cost $400,000. It will have two roadways, two street railway tracks and two sidewalks.

HAMILTON, O.—A compromise has been made on the bridge question. It is now stated that the commissioners will build a new suspension bridge across the river from High to Main Sts. for $65,000, and the Black St. bridge is to be built at a cost of $35,000.

RIVERTON, VA.—The State Legislature has passed a bill authorizing Warren Co. to borrow $12,000 for the construction of a bridge over the Shenandoah River.

MT. VERNON, WASH.—The County Commissioners have advertised for bids for building a bridge across the Skagit River. The bridge will be 600 ft. long, with a draw span of 200 ft. Bids will be received up to April 1. The bridge will cost $25,000 or $30,000.

NEW YORK CITY, N. Y.—Two Harlem Bridge bills are before the Legislature of New York. The first authorizes New York City to appropriate $1,000,000 for a drawbridge across the Harlem at 145th St., and the second authorizes a drawbridge, to cost $1,250,000, across the river at the north end of First Ave.

WATER-WORKS.

New England.

BERLIN, N. H.—It seems that the town will vote on building works or allowing the Berlin Aqueduct Co. to build.

CHESTER, N. H.—A small works is talked of, and will be voted on soon.

ST. JOHNSBURY, VT.—A committee has estimated that it would cost $65,000 to bring water from Joe's Pond, not including a distributing reservoir.

CHICOPEE, MASS.—The Chicopee Water Co. has decided to make improvements. Clk., E. R. Stickney.

ANDOVER, MASS.—The Water Commissioners have been authorized to petition the legislature for authority to issue $40,000 of bonds to extend the works.

READING, MASS.—The Water Commissioners have been instructed to ask for authority to issue $50,000 of bonds for extensions.

PROVIDENCE, R. I.—Filtration is under discussion.

Middle.

BABYLON, N. Y.—The parties proposing to supply Babylon, Amityville and Lindenhurst have elected Benjamin R. Wood, Secy., and W. F. Norton, Prest., both temporarily. A capital stock of $15,000 is proposed.

EAST SYRACUSE, N. Y.—The Village Board has voted to call an election to decide regarding the issuance of $50,000 of bonds for works.

MAYVILLE, N. Y.—After much opposition village trustees in favor of works have been elected.

POUGHKEEPSIE, N. Y.—The Anderson Revolving Purifier Co. have made a proposition to put in a filtering plant. Large filter beds are now used. The above proposition is under consideration.

SYRACUSE, N. Y.—Bids will be asked by the City Water Commissioners for the rebuilding of a dam and gate-house at Skaneateles Lake, dredging of the lake and outlet, and for laying 6,000 ft. of 54-in. inlet pipe.

ALBANY, N. Y.—The Water Commrs. will receive bids until March 15 for mains and specials. Prest., R. L. Banks.

BOONTON, N. J.—A recent fire has called attention to the need for works.

LANSDOWNE, PA.—The Lansdowne Water Co. has bought land for the location of a pumping station on Naylor's Run. A reservoir will also be constructed. It is said that the supply from artesian wells has become inadequate.

MARTINSBURG, PA.—The new company proposes to bring water from a spring three miles distant.

MONTROSE, PA.—Works are under discussion by the council.

MARTINSBURG, PA.—The Martinsburg Water Co. was chartered March 5 to supply water to Martinsburg and vicinity. Population of Martinsburg borough 588. Capital stock of company, $20,000. Wm. Nicodemus, of Martinsburg, is treasurer.

DARBY, PA.—Six companies have been chartered under various names to supply water to Darby borough and township, Upper Darby, Sharon Hill, Tinicum township and Ridley township, adjacent localities in Delaware Co., a few miles southwest of Philadelphia. Each company has an authorized capital stock of $1,000 and begins business with $100. Walker Y. Hoopes, of Media, Pa., is treasurer of all the companies.

BRADFORD, PA.—Investigations are being made for an increase to the supply by building a dam.

EVERETT, PA.—Water-works and electric lights are being discussed.

MANILLA, IA.—A vote on building works will be taken March 14.

BLUE SPRINGS, NEB.—Extensions are talked of.

McKEESPORT, PA.—The Water Commissioners recommend the expenditure in the coming year of $5,000 for boilers, $26,000 for pumps, etc., $30,000 for new mains and hydrants, and $20,000 for high service and other improvements.

MARTINSBURG, PA.—It is reported that the Martinsburg Water Co. has been incorporated; capital stock, $20,000.

NEWMANSTOWN, PA.—The Newmanstown Water Co. has secured the water of three springs at South Mountain, and proposes to lay a 6-in. cast iron pipe 1¼ miles to the village and a 4-in. pipe through the village.

NEW MILFORD, PA.—Steps to incorporate the New Milford Water Co. are being taken. Address Geo. Pratt or C. S. Vail.

PHILADELPHIA, PA.—Council's Water Committee has approved plans of Director Windrim for the expenditure of $500,000 for extensions.

STEWARTSTOWN, PA.—A reservoir is projected for water-works.

TANEYTOWN, MD.—Address the Mayor regarding proposed works. A bill authorizing the same is before the Legislature.

CUMBERLAND, MD.—Authority to build new works is being sought.

Southern.

BERRYVILLE, VA.—The Legislature has authorized the town to borrow $15,000 for the construction of works.

LENOIR, N. C.—Address the Mayor for information regarding proposed works.

SUMTER, S. C.—The American Pipe Co., Philadelphia, is trying to secure the contract for works here.

CUTHBERT, GA.—A vote will soon be taken on putting in water and electric lighting plants.

PLAQUEMINE, LA.—The Council has accepted the proposition of the Plaquemine Water Works Co. to furnish 50 hydrants at $50 each per year. At the end of 50 years the whole plant will be turned over to the city free of cost.

DANVILLE, KY.—John Geary, of Lexington, and others wish to put in works, but municipal ownership seems to be favored.

MT. STERLING, KY.—J. W. Hedden informs us that John T. Foley, Nashville, Tenn., has reorganized the water company. Works were projected summer of 1891.

LUDLOW AND WEST COVINGTON, KY.—Ludlow wishes West Covington to join with it in securing works. Surveys for a 12-in. pipe line have been ordered.

North Central.

BOWLING GREEN, O.—March 1, at the postponed election the proposition to grant a franchise to T. W. Newcomer, Cleveland, was defeated.

MADISONVILLE, O.—A popular vote will be taken on the issuance of $30,000 for the building of works.

SALINEVILLE, O.—The people have voted in favor of works.

BAY CITY, MICH.—The city has adopted the Gregg & Bloomshield fire hydrant and ordered 25.

GRAND LEDGE, MICH.—It is hoped that works will be built.

WINNETKA, ILL.—Plans and specifications for the new works are being prepared by W. S. Mac Harg, C. E., Commerce Building, Chicago.

MAYWOOD, ILL.—The town would probably grant a franchise to reliable parties to build and maintain works.

RIVER FOREST, ILL.—If the well now being sunk by citizens is a success works will probably be established.

APPLETON, WIS.—The Appleton Water Works Co. has been reorganized with a capital stock of $200,000; incorporators, J. C. Rogers, H. D. Ryan and A. B. Whitmen.

MARSHFIELD, WIS.—A press dispatch states that the council has granted a franchise to Gray Bros., Whitewater, but it is thought that the Mayor will veto it.

MILWAUKEE, WIS.—The Board of Public Works will receive bids until March 18 for constructing and erecting a vertical triple expansion pumping engine of 8,000,000 gallons capacity; also a cylindrical boiler; also 75 double-nozzled fire hydrants, either of the single valve Mathews or improved Stowell pattern.

Northwestern.

ELDON, IA.—A public meeting was held March 4 to discuss the building of works.

MILTON, IA.—The "Independent" favors the introduction of works.

ORANGE GROVE, IA.—Proposals for the construction of a plant complete will be received until March 21. Engr., S. K. Felton, Omaha, Neb. Recorder, A. J. Kuyper. Mayor, A. Bolks.

HOLDREGE, NEB.—The city has bought the works for $40,000 from W. A. Paxton, Omaha.

Southwestern.

HARRISON, ARK.—It is reported that works are projected.

HANNIBAL, MO.—The contract for constructing the reservoir has been awarded to Fielder & Thornton, Hannibal.

ST. LOUIS, MO.—Bids for building a gate house on the Chain of Rocks inlet tower will be received until March 22. Geo. Burnet, Pres., Bd. Pub. Improvements.

WINDSOR, MO.—In its efforts to secure the State University, Windsor has offered to build water and electric lighting plants.

SAN ANTONIO, TEX.—The West End Water Co. has been incorporated by Geo. W. Russ, Geo. A. Russ and Frank N. Dowden. Capital stock, $100,000.

SPRINGTOWN, TEX.—A contract for works has been let.

SULPHUR SPRINGS, TEX.—The Hall Engineering Co. has made a proposition to put in works.

VICTORIA, TEX.—There is talk of adding 25 ft. to the height of the stand-pipe. The City Engineer thinks it unnecessary and favors pipe extension instead. Supt., Wm. Wheeler.

YOAKUM, TEX.—The Yoakum Improvement Co. has contracted to have works in operation by June 3, 1892. There will be a 12x100-ft. stand-pipe and about 2½ miles of mains.

CREEDE, COLO.—The Union Water & Power Co. has been incorporated to put in works at Creede, Creedemore and Jimtown; capital stock, $100,000.

Pacific.

MEDICAL LAKE, WASH.—The town has voted, 127 to 7, to issue bonds for works.

WAITSBURG, WASH.—The city is taking steps to secure a right of way for its supply main. The sum of $25,000 was recently voted for works.

SALEM, ORE.—The Salem Water Co. will extend its mains. About 2,200 ft. of 30-in. pipe will be laid.

SHERIDAN, ORE.—A public meeting to discuss works will be called.

TREMONT, ORE.—The Tremont Light & Water Co. has been incorporated; capital stock, $10,000.

LEMOORE, CAL.—A direct pumping system will be introduced. Address E. Erisinger.

VISALIA, CAL.—The Visalia Water Co. has been incorporated; directors, Arthur Crowley, J. F. Jordan and others; capital stock, $50,000. Mr. Crowley owns or was the former owner of works here.

Canada.

FAIRVILLE, N. B.—Application has been made by Chas. F. Woodman, Jas. Ready, Allston Cushing and others for incorporation as the Fairville Water & Light Co.; capital stock, $100,000.

VANCOUVER, B. C.—The Vancouver Water-Works Co. formally transferred its works Feb. 29, for $450,000.

ARTESIAN WELLS.

JENKINTOWN, PA.—The Jenkintown Water Co. will try to secure water in another place. A hole has been bored 349 ft. without finding water.

RANDOLPH, NEB.—Bonds to the amount of $5,000 for putting in a well are proposed.

ALPENA, S. DAK.—An artesian well to drive a flour mill is proposed.

ALBANY, TEX.—A well is wanted. Address Geo. T. Reynolds.

EMMA, TEX.—A well is wanted.

GALVESTON, TEX.—Bids are wanted for sinking one or more wells at North Galveston by E. H. Porter, 2212 Mechanic St.

HILLSBORO, TEX.—The Council has decided upon wells as a supply for water works.

CENTREVILLE, WASH.—The farmers in the vicinity talk of sinking a well.

IRRIGATION.

ANTONITO, COLO.—A press dispatch from this point states that Taos Valley Co. has resumed work on its canal, which will be, as prospected, 70 miles long. A dam of masonry in cement, 55 ft. high, is being built.

YAKIMA, WASH.—The Yakima Irrigation & Improvement Co. proposes to build a 28-mile ditch this summer at a cost of $100,000.

SEWERS.

MANCHESTER, N. H.—The annual appropriation for the street and sewer departments is $162,800, of which $30,000 is for sewers and drains and $28,500 for paving and grading.

BOSTON, MASS.—Bids are asked by the Metropolitan Sewerage Commissioners, until April 2, for building section 26, in Charlestown and Somerville. Approximate length, 4,250 ft.; average depth, 23 ft.; external diameter, 8'6 ft.; brick and other masonry, 3,150 cu. yds. The contract for building section 14, in Chelsea, has been awarded to the Metropolitan Construction Co., at $146,856. The bids for section 13 were thrown out.

PITTSFIELD, MASS.—Bids are asked by the Board of Sewer Commissioners, until March 19, for about 1,800,000 hard burned brick, 200 cast iron manhole covers and rings, 5,000 bbls. Rosendale cement, and 2,000 bbls. Portland cement; also, until March 26, for constructing about 3½ miles of brick and 11 miles of pipe sewers, the pipe, brick, etc., to be furnished by the city.

BROOKLYN, N. Y.—Bids are asked until March 18 for the construction of sewers in two streets. John P. Adams, Comr. Pub. Wks.

HORNELLSVILLE, N. Y.—The plans and specifications for the proposed system are about completed by Mr. C. P. Bassett, Engr., and it is desired that bids be asked so that construction may begin April 1.

NIAGARA FALLS, N. Y.—The contract for section 2 of the sewer system has been awarded to C. N. Stainthorpe & Co., of Lockport, at $15,900. The Village Treasurer will receive bids until March 22 for $100,000 of sewer bonds. The total issue will be $250,000.

ONEIDA, N. Y.—Maps and plans for a complete system of sewers have been prepared by Mr. W. F. Randall, assisted by Mr. E. Kuichling, of Rochester. The plans will be submitted to the State Board of Health.

TONAWANDA, N. Y.—Sewer bonds for $150,000 have been sold.

TROY, N. Y.—Sewers are to be built in three streets.

READING, PA.—The city desires to issue bonds for $1,000,000 for sewers and street paving. The City Engineer is preparing estimates for sewers in three districts.

BIRMINGHAM, ALA.—The street committee has reported in favor of a sewer extension to cost $14,000.

NASHVILLE, TENN.—The City Engineer will receive bids for the construction of the West Nashville sewer, for which $45,000 has been appropriated.

CINCINNATI, O.—A sewer contract has been awarded to Mr. C. Cronan, at $13,385, the lowest of seven bids.

CLEVELAND, O.—Bids are asked until March 16 for sewers in three streets; March 23, in eight streets; March 30, in four streets. R. R. Herrick, Director Pub. Wks.

COLUMBUS, O.—The city has purchased a sewer farm of 77 acres, subject to the approval of the Legislature.

FINDLAY, O.—The Mayor will receive bids until April 4 for $20,000 of sewer bonds.

SPRINGFIELD, O.—Bids will be opened March 31 for two sewers. The City Engineer has prepared estimates for 12,182 ft. of sewer, to cost $27,651.

PEORIA, ILL.—The Board of Aldermen has passed an ordinance for a system of sewers in sewer district No. 6.

WINNETKA, ILL.—The contract for constructing 18,000 ft. of 33-in. and 8-in. sewers has been awarded to Cook & Heaton, of Johnson City, Kan., at $28,500. W. S. MacHarg, of Chicago, is Engineer.

FT. DODGE, IA.—Mr. C. F. Loweth, of St. Paul, has been engaged to prepare plans and estimates for a system of sewerage.

	Earth Excav. and Refill.		Brick Masonry.		Conc. Mas.	Rubble Mas.	Spruce Lumber	Spruce Piles	
	Am. 3,690	Portl. 120	Am. 3,220	Portl. 750	Am. 1,300	Portl. 500	Am. 100	in place. 30 M.	driven. 10,000	
Sec. 13.	lin. ft.	lin. ft.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	ft. B. M.	lin. ft.	Total.
	$	$	$	$		$	$		Cts.	$
1	41.75	41.75	12.81	14.81	5.95	7.95	5.75	33.00	17	226,398
2	38.15	38.15	13.36	15.00	5 00	7.25	5.50	35.00	18	213,145
3	28.25	28.00	13.50	15.00	6.00	7.50	6.00	.00	15	176,812
4	30.00	20.00	11.00	14.00	6.00	7.50	6.00	40.00	20	174,370
5	29.27	14.52	12.37	14.31	5.27	7.28	5.00	35.00	14	173,753

	Earth Excav. and Refill.			Brick Masonry.			Concrete Masonry.			Rubble Stone	Spruce Lumber	Spruce Piles	
	Tr'ch. 2,470	Tr'ch. 120	Tunn'l. 850	Am. Tr'nch. 2,100	Am. Tunn'l. 820	Portl. Tr'nch. 510	Portl. Tunn'l. 150	Am. Tr'nch. 1,120	Am. Tunn'l. 50	Portl. Tr'nch. 500	Portl. Tunn'l. 50	Am. 100	in place. 30 M.	driven. 10,000	
Sec.	lin. ft.	lin. ft.	lin. ft.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	cu. yds.	ft. B. M.	lin. ft.	Total.
	$	$	$	$	$	$	$	$	$	$	$	$		Cts.	$
1	36.50	36.50	39.96	15.00	15.00	16.50	17.50	9.00	12.00	11.50	14.50	10.00	20.00	15	203,596
2	29.54	29.00	41.34	14.00	20.00	17.37	23.37	6.00	11.00	8.75	13.75	7.00	30.00	20	185,679
3	31.00	31.00	39.20	14.00	15.00	15.50	17.00	4.50	6.50	6.00	9.00	5.00	30.00	25	178,480
4	32.19	32.19	30 00	13.36	19.16	15.00	20.80	5.00	10.00	7.25	12.50	5.50	35.00	18	177,159
5	26.50	26.00	37.00	13.50	16.00	15.00	18.00	6.00	8.50	7.50	10.00	6.00	28.00	15	166,180
7	28.00	20.00	35.00	11.00	13.00	14.00	17.00	6.00	8.00	7.50	9.50	6.00	40.00	20	159,905
7	26.00	14.52	28.00	12.11	13.94	14.06	16.00	4.92	5.98	6.88	9.25	5.00	35.00	14	148,856

FREMONT, NEB.—The city will vote in April on the question of issuing bonds for $100,000 for the proposed sewerage system.

ST. LOUIS, MO.—The Board of Public Improvements asks bids until March 16 on nine sewer contracts.

GEORGETOWN, COLO.—The council has prepared specifications for 4,000 ft. of sewers, the contracts for which will soon be let.

SANTA BARBARA, CAL.—Bids are asked by the Common Council until March 24 for the outfall sewer.

STOCKTON, CAL.—The contracts for engines, boilers and pumps for the sewage-pumping station has been awarded to the Risdon Iron Works, of San Francisco, at $9,850.

STREETS.

BOSTON, MASS.—The Street Commissioners estimate the cost of widening and extending Van Rensselaer Place at $475,000. An appropriation of $16,000 was recommended for widening Park St. The finance committee is considering orders for $83,500 for street improvements in Charlestown, and $114,500 for West end improvements.

HOLYOKE, MASS.—The city has voted $20,000 for paving one street each with asphalt blocks and granite blocks.

BUFFALO, N. Y.—The Committee on Streets has reported in favor of paving one street each with asphalt, vitrified brick, Medina stone and American bituminous rock.

NEWARK, N. J.—It is intended to ask bids soon for nearly 16 miles of paving.

FRANKLIN, PA.—Bids are asked until March 15 for paving three streets, the city to furnish the brick.

PHILADELPHIA, PA.—The Highway Committee has voted in favor of paving, for which Director Windrim's estimates are as follows: Broad St., with asphalt, $134,278; other asphalt work, $77,789; new granite block, $28,105; old granite block, $40,102: total, $340,273.

BALTIMORE, MD.—Bids are asked until March 18 for repaving Broadway with sheet Trinidad asphalt; also for about 13,000 ft. of 6-in. granite curbing and about 2,600 sq. yds., or about 69,000 Belgian blocks. A. E. Smyrk, City Comr.

CINCINNATI, O.—Bids are asked until March 18 for grading, curbing and macadamizing one street; March 19, paving one street each with brick and cobblestone; March 23, paving one street with granite blocks. Fols & Jones have been awarded contracts for paving four streets with granite blocks, at $93,924. The Legislature has authorized the Commissioners of Hamilton Co. to extend and improve West Eighth St., and to issue bonds for $50,000 to pay for the same.

CLEVELAND, O.—Bids are asked until March 16 for paving in two streets with Medina sandstone, and for grading and improving eight; also until March 30 for paving with Medina stone in three streets, and with brick in two streets. R. R. Herrick, Director Pub. Wks.

ZANESVILLE, O.—The city has sold $50,000 of street and sewer bonds.

MARION, IND.—The city will spend $40,000 in brick paving in the spring.

BEATRICE, NEB.—The city will vote April 5 on the issuing of $15,000 of paving bonds.

SAN FRANCISCO, CAL.—The Street Committee has voted to pave one street with basalt blocks and 13 with bituminous rock.

ELECTRICAL.

BUFFALO, N. Y.—Bids are asked until March 16 for lighting certain streets and squares with arc lights of 2,000 c. p. Maps and plans can be seen at the office of the city engineer.

LEWISBURGH, PA.—Bids for a five years contract for street lighting have been asked.

GREENVILLE, MISS.—Bids are asked until April 1 for street lighting. J. M. Lee, City Clerk.

CLEVELAND, O.—Bids are asked until March 30 for about 20 arc lights of 4,000 c. p. and 129 of 2,000 c. p. R. R. Herrick, Director Pub. Wks.

JEFFERSON CITY, MO.—The Mayor has called a special election to vote on the question of electric lighting.

PHILIPSBURG, MONT.—The town has contracted with the Philipsburg-Granite Electric Light Co. for eleven arc lights of 2,000 c. p., at $15 each per month.

CONTRACT PRICES.

SEWERS.—Boston, Mass.—Bids have been opened by the Metropolitan Sewerage Commission for constructing Sections 13 and 14, Chelsea. The bidders for Section 13 were as follows: 1, National Construction Co., Boston; 2, Charles G. Craib, Chelsea; 3, Jones & Meehan, Jamaica Plain; 4, Everson & Liddle, Providence, R. I.; 5, Metropolitan Construction Co., Boston.

For Section 14, the bidders were as follows: 1, Hart, Anderson & Barr, Brooklyn, N. Y.; 2, Aaron A. Hall, Boston; 3, Empire Construction Co., New York City; 4, Charles G. Craib, Chelsea; 5, Jones & Meehan, Jamaica Plain; 6, Everson & Liddle, Providence, R. I.; 7, Metropolitan Construction Co., Boston.

Bids were opened March 8 for building section 3 of the outfall sewer at Moon Island, the estimates including A, 1,865 lin. ft. earth excavation and refilling; B, 1,311 cu. yds. brick masonry, American cement mortar; C, 482 cu. yds. same, Portland cement mortar; D, 7,500 cu. yds. concrete masonry; E, 5 yds. dimension stone masonry. The bidders were as follows: 1, Aaron A. Hall; 2, John Cavanagh & Co.; 3, National Construction Co.; 4, Perkins & White; 5, H. P. Nawn.

	A	B	C	D	E
1	$15.86	$13.81	$15.68	$6.16	$40
2	12.40	13.00	15.00	5.75	40
3	10 50	11.75	13.25	4.89	20
4	9.60	12.00	14.00	4.20	40
5	10.08	12.40	14.00	4.25	20

STREET MATERIAL.—Baltimore, Md.—The following were the lowest bids received for furnishing material for the City Commissioner's department for the current year; Stuart R. Carr, gutter plates, $1.22 per 100 lbs.; James H. Atkinson, flag stones, 26 cts. per sq. ft., and Belgian blocks, $1.40 per sq. yd.; Port Deposit Granite Co., cobble stones, $1.65 per perch, and gutter stones, 27 cts. per lin. ft.

BRICK.—Massillon, O.—The contract for paving South Erie St. has been awarded to Geo. W. Lemmon, of Wheeling, W. Va., for Massillon brick at $11.50 per M.

Portland, Me.—The contract for furnishing 60,000 brick for the Cuckold Island fog signal station, has been awarded to N. Bryant, of New Castle, Me., at $9.50 per M. delivered at West Harbor.

CEMENT.—Washington, D. C.—The contract for Portland cement for the Congressional Library has been awarded to the Jackson-Jones Co., of Washington, D. C., at $2.53 per bbl.

DREDGING.—New York, N. Y.—The following bids have been received at the U. S. Engineer Office, for dredging 30 000 cu. yds. at Port Jefferson Inlet, N. Y.: Elijah Brainard, New York City, 54 cts. per cu. yd.; Hartford Dredging Co., Hartford, Conn., 35 cts.; Richard Parrott, Newburgh, N. Y., 21½ cts.

Philadelphia, Pa.—The Board of Port Wardens has awarded the contract for dredging the Delaware and Schuykill rivers to the American Dredging Co. at 15.3 cts. per cu. yd.

PIPE AND CASTINGS.—Lowell, Mass.—The Water Board has awarded the contract for 700 tons of pipe and special castings to the Radford Pipe & Foundry Co., of Radford, Va., at $25.50 per ton for the pipe and 2¼ cts. per lb. for the specials. This was the lowest of 12 bids and includes delivery.

New Bedford, Mass.—The Water Board has awarded the following contract to the New Bedford Iron Co.: 8,000 lbs. stop boxes at $2.95 per 100 lbs.; 12,000 lbs. gate boxes and 5,000 lbs. branches and other castings at $2.40 per 100 lbs. This was the lowest bid.

SIDEWALK.—Birmingham, Ala.—The contract for 5,000 sq. yds. of 8 in. asphalt block sidewalk has been awarded to the Southern Supply Co., at $1.44 per sq. yd.

ASPHALT PAVING.—Cincinnati, O.—For paving Fourteenth St. with asphalt, James Finnigan bid $2.64 per sq. yd., and the Warren-Scharf Asphalt Co. $2.83.

MISCELLANEOUS.

PUBLIC BUILDINGS.—The Senate Committee has reported bills for buildings at Brockton, Mass., $75,000; Boise City, Idaho, $200,000; Washington, D. C., additional building for the National Museum, $500,000; and bills have been introduced for buildings at Findlay, O., Meadville, Pa., and Woonsocket, R. I., $100,000 each.

GAS.—Buffalo, N. Y.—Bids will be received by the City Engineer until March 16 for furnishing gas for the street lamps and the public buildings for three or five years.

Brooklyn, N. Y.—Bids are asked until March 16 for gas for street lamps and public buildings for the current year. John P. Adams, Comr. Pub. Wks.

STREET SUPPLIES.—London, Ont.—Bids are asked until March 17, for plank and artificial stone walks, sewer pipe, cement, gravel, paving stone, cedar block crossings, etc. Ormsby Graydon, Cy. Engr.

IRON AND STEEL.—Chicago, Ill.—Bids will be received at the U. S. Engineer Office until March 30 for furnishing the iron and steel for the lock gates and filling valves at Kampsville Lock, Illinois River. Steel, 40,200 lbs.; wrought iron, 45,000 lbs.; cast iron, 112,500 lbs. Capt. W. L. Marshall.

DREDGING.—Buffalo, N. Y.—The Board of Public Works asks bids until March 17 for dredging Blackwell Canal, 56,000 cu. ft.; Peck Slip, 3,000 cu. ft.; Buffalo River, 63,000 cu. ft.; Buffalo Harbor, 30,000 cu. ft.

WHARF.—Ottawa, Ont.—Bids are asked until March 18 for the extension of the ballast wharf at Campbellton, Restigouche Co., N. B. E. F. E. Roy, Secy. Dept. Pub. Wks.

BRICK.—Minneapolis, Minn.—The City Engineer has been directed to ask bids for 1,000,000 sewer brick.

STONE DAM AND PIPE.—Syracuse, N. Y.—The Water Board will receive bids until March 23 for taking down the State's stone dam in the outlet of Skaneateles Lake, lowering the foundation about 6 ft. and rebuilding the dam; also for taking down, moving and re-erecting the stone abutments of the bridge over the outlet of the lake at Main St.; also for deepening the channel and outlet, constructing gate house, crib, trench, etc. Bids are also asked for about 6,500 lin. ft. of single riveted steel pipe, including 8 to 16 flexible pipe joints, 54 ins. internal diameter and ⅜ in. thick. The sections are to be of 29 ft. length and afterward riveted into lengths of 116 ft., the pipe to be coated with asphaltum.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., are building 6 ten-wheel engines for the Toledo & Ohio Central.

CARS.—The Gilbert Car Mfg. Co., Troy, N. Y., has an order for 10 cars for the Chicago & South Side elevated road. The Barney & Smith Mfg. Co., Dayton, O., is building 12 passenger cars for the Lake Erie & Western. The Duluth Mfg. Co., Duluth, Minn., and the Iron Car Co., New York, N. Y., have orders for freight cars for the Lake Erie & Western. The J. G. Brill Co., Philadelphia, Pa., has built 10 electric cars for the Central Traction Co., Pittsburg, Pa.

POLES.—Milliken Bros., New York, manufacturers of steel poles for electric light and railway wires, state that in consequence of the great demand for these poles in other countries, arrangements have been made to have them manufactured in Europe.

THE PITTSBURG TESTING LABORATORY, Pittsburg, Pa., has the contract for inspecting all the iron work, about 3,000 tons, for the St. Louis terminal station. The work will be done under the supervision of Mr. W. C. Aiken, M. Am. Soc. C. E., the company's representative at Chicago.

THE GROTON BRIDGE & MFG. CO., Groton, N. Y., has the contract for a large bridge at Huron, Mich., three spans at Danville, Pa., and several small spans. The company has completed the bridge across the Potomac at Hancock, Md., and will soon commence the erection of a three-span bridge at Caribou, Me.

CURRENT PRICE LIST.

RAILS.—New York: $30 at eastern mills; old rails, $20 to $20.50 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $22 to $22.50 for iron and $16.75 to $17 for steel. Chicago: $31.50 to $32; old rails, $20 75 to $21 for iron and $14 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 1.95 to 2.05 cts.; track bolts, 2.6 to 2.75 cts., with square and hexagonal nuts. Pittsburg: splice bars 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and steel; spikes, 2.15 to 2.2 cts.; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½% on black and galvanized butt-welded; 67½ and 55% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $14 to $17.50. Pittsburg: $14 to $15.75. Chicago; $14 to $16.

LEAD.—New York: 4.15 to 4.2 cts. Chicago: 4 cts. St. Louis: 3.9 to 3.95 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.3 to 2.5 cts.; angles, 1.85 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.8 to 2.25 cts.; steel plates, 1.85 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.25 to 2.35 cts.; channels, 2.25 to 2.35 cts.; angles, 1.9 to 1.95 cts.; tees, 2.5 cts.; universal iron mill plates, 1.95 to 2 cts.; sheared steel bridge plates, 1.9 to 2 cts.; refined bars, 1.75 cts.; steel plates, 1.9 to 2 cts. for tank, 2.15 to 2.2 cts. for shell, 2.3 to 2.35 cts. for flange, 3.75 to 4.15 cts. for firebox. Chicago: beams, 2.25 to 2.4 cts. for standard, 2.37 cts. for small, and 2.7 cts. for 20-in.; channels, 2.67 to 2.75 cts.; angles, 1.95 to 2.1 cts.; tees, 2.5 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.4 to 2.5 cts. for tank, 2.65 to 2.75 cts. for shell, 2.9 to 3 cts. for flange.

50 Cts. **WANTS.** 50 Cts

WANTED—All consulting engineers, corporations, contractors, etc., to read Paret's advertisement about surveys. See page III.

WANTED—Continuous girders to calculate—either constant or variable Moment of Inertia—New Graphical method—My own invention. Address C. H. LINDENBERGER, Wayne Hotel, Detroit, Mich. 35-52t

WANTED.—Ex-chief engineer, Yale graduate, who understands Spanish, and has had 18 years experience in United States, state, municipal and railway engineering work, and with credentials of the highest character, solicits correspondence with a view to an engagement. Address "X.," Engineering News. 4-15t

WANTED—A civil engineer, aged 34, desires employment. Experience in railway reconnoissance, location and construction, and in municipal engineering. Have just completed 13 sections and terminals at Roanoke, Va., for the Roanoke & Southern Ry. Refer to Andrew Onderdonk, Chief Engineer, R. & S. Ry., Winston, N. C. H. W. NEWBY, Alexandria, Va. 7-4t

WANTED—A position as office man in engineer's office; capable clerk and accountant, neat draftsman, etc. Nine years experience; disengaged in March. Address M. C., care Engineering News. 7-6t

WANTED

A practical clay worker, with some capital, to take an interest in and superintend a plant for the manufacture of sewer pipe and other clay products, in a large Southern city, with railroad and water transportation in all directions, and where it will command the increasing demand for such products in the South. The best of clay exists in great variety and abundance, and a profitable contract can be made at once for more than 20 miles of pipe. Address, ED. N. KIRK TALCOTT, Civil and Mechanical Engineer, 57 Broadway, New York. 9-4t

WANTED—A position as shop superintendent of a first class bridge shop. Have had 20 years' experience and thoroughly understand the best methods of getting out all the different classes of work. Am at present superintendent of a shop of 500 tons per month capacity. Good reasons for desiring a change. Can give good references. Address H., care Engineering News. 8-3t

AXEMAN.—Young college man, six months' railroad experience, will take any subordinate place in field or office. Southwest preferred. Reference. Address ANYTHING, Engineering News. 9-3t

TO LEASE—For a term of years a cement property in a new territory, for about one-half its actual value, along a line of railroad. Cement can be made for the minimum cost. To parties interested it will pay to look into this. Address R. O. BEITEL, Nazareth, Pa. 9-2t

WANTED—Steam shovel runners and cranesmen. Souther shovel Night work. One hundred dollars per month.
CHARLES McFADDEN & SONS,
9 5t North Hector, N. Y.

WANTED—An engineer of 20 years' practical experience on railroads in the North, South and West is open to an engagement. Will accept position as chief of party on preliminary or location, or division engineer on construction, or as engineer in charge for a good contracting firm. Have complete set of field instruments. Best of references can be furnished. Will be glad to confer with parties desiring the services of an engineer. Address T. G. BAYLOR, Charlestown, Jefferson County, West Va. 9-4t

WANTED.—A graduate civil engineer of eight years' experience on first class railroads desires engagement to make location surveys, estimates and specifications, or to take charge of construction; has complete outfit. Address A.B.C., Engineering News. 9-3t

WANTED—Position by first class draftsman; six years' practical experience on city and railroad work. Best of references. Address "DRAFTSMAN," care Engineering News. 9-3t

WANTED—Pamphlet on "Application of the Principle of Virtual Velocities to the Determination of Stresses and Deflections in Frames," by Prof. G. F. Swain, or the numbers of Journal of Franklin Institute (February, March and April, 1883) in which it was originally printed. CHARLES W. COMSTOCK, 9 East Buffalo St., Ithaca, N. Y. 9-2t

WANTED.—A young man with technical education (Yale College) desires position as rodman, draftsman or assistant where he will have opportunity for advancement. Address L. W. W., care of Engineering News. 10-1t.

WANTED.—Assoc. Am. Soc. C. E. would like employment as bridge draftsman. Experience as computer for unusual and peculiar designs and as an author. Address L., care Engineering News. 10-3t.

ENGINEERING EMPLOYMENT BUREAU,

ESTABLISHED 1890
Invites Correspondence with Parties Needing
Engineers, Superintendents or Draftsmen.
No Charge Whatever to Employers.
8 GRANGER BLOCK, SYRACUSE, N. Y.

WANTED.—Civil engineer and A1 topographical draftsman, European graduate with 12 years' American experience on railroads, mines, town sites and general surveying in the West and East is open to engagement; has first class instrumental outfit for office and field. Address ACCURATE, care Engineering News. 9-3t

WANTED.—Graduate Civil Engineer, engaged several years at drafting, figuring and designing all kinds iron structures and bridge work, and who has been engaged in contracting all over the country, desires engagement with a reliable firm. If for taking contracts exclusively money only object. Address E. B. P., No. 118 Diamond St., Pittsburg, Pa. 9-6t

WANTED—Position by young graduate engineer, with considerable experience in hydraulic and municipal engineering. Desires to get on structural iron work, but will take anything. Good draftsman, calculator and mechanical worker; understands graphics; experience more desirable than salary. F. G., care Engineering News. 9-3t

WANTED—Position in mechanical or topographical drawing room at tracing. Have experience and good reference. Address 146 Neshannock Ave., New Castle, Pa. 10-1t

WANTED.—Roadmaster and graduate engineer, good manager and disciplinarian, thoroughly acquainted with the best practice, wishes to change location. At present with large trunk line. Wishes position as engineer maintenance of way or supervisor. Best references. Address R. R., Engineering News. 10-3t

WANTED—Position by civil engineer, age 35, good instrument man, topographer and draftsman, with experience in the design and construction of sewerage, water works, roads, harbor improvements, foundations and heavy masonry. Best references. Address STADIA, care Engineering News. 10-6t

WANTED—By a young graduate engineer, a position as transitman, leveler or draftsman. Have had experience in land surveying and railroad construction and am fair draftsman. Address, "J. K." care of ENGINEERING NEWS. 10-2t

WANTED—A position as rodman or chainman; am a fair leveler. Best of reference, will go anywhere. I want steady work, not large pay. Address W. H. CHRISTIE, Van Ettenville, N. Y. 10-3t.

WANTED.—A situation as general office man and draftsman in either city or railway engineer's office. Twenty years' experience in civil engineering. References, if required. Box 185, Brooklyn, N. Y. 10-3t

WANTED.—A bridge engineer, with extended experience in designing and estimating R. R. bridges, and who has also had charge of the drafting room of a large works, desires an engagement. Address A. A., care Engineering News. 10-3t

WANTED.—Young engineer who wishes to combine office and field practice desires position. Will be disengaged April 1. Graduate American technical school; 2½ years' experience. Best of references given. Address "OFFICE AND FIELD," care of Engineering News. 10-3t

WANTED.—Engineer experienced in location and construction and handling large bodies of men, wants position. Will go anywhere. Address A. G. F., Box 395, Hoopeston, Ill. 10-3t

WANTED—Indices to volumes 17, 21, 22, 24; will give 8 cents each for them.

WANTED—Engineering News for Jan. 7, Apr. 15, 1882; Dec 29, 1883; May 30, 1885; July 13, 20, Nov. 30, 1889; Jan. 11, Mar. 15, Feb. 4, Oct. 31, 1890. Will pay 12 cents a copy. Put name on wrapper when sending papers.

WANTED.—Bridge draftsman and engineer wants a position. Experienced designer of iron bridges and buildings and capable of taking charge of drafting room in a bridge building concern. Address H. S., care Engineering News. 10-4t

WANTED—By a young man, graduate School of Mines, Columbia College, New York, position in some branch of the civil engineering profession. Field and office experience. References. Address
10-1 C. C., care Eng. News.

WANTED—Bridge engineer, with 11 years experience, wants position. Perfectly familiar with making shop drawings, as well as estimates on all kinds of bridge and roof work. Address BRIDGE, care Engineering News. 11-3t

WANTED.—A graduate civil engineer of 10 years' experience on railway and government work desires engagement; is especially experienced as a locating engineer in a mountainous country and in heavy railroad construction. Address C. D., Engineering News. 9-3t

WANTED—A young man, graduate, C. E. School of Mines, Columbia College, New York, would like position as assistant to some suburban engineer. Permanency of more object than salary. Field and office experience. References. Address
10-1t "WORK," care Eng. News.

WANTED—Engagement in an Engineer Corps by a young engineer, graduate of Cooper Institute. Had four months experience as transit and level man in a R. R. location corps. Would prefer construction or tunneling, but will take anything or go anywhere. Address Q. E. D., care ENGINEERING NEWS. 10-3t

WANTED—Position as superintendent of water-works system, thoroughly competent to take full charge, and is familiar with all kinds of work connected with water-works plant. Has eight (8) years experience. Satisfaction guaranteed. Can give undoubted reference. Address R. J., care Engineering News. 9-2t

WANTED—Position by civil engineer as transitman, rodman or tapeman on railroad or city work, or as assistant in any surveying or engineering work. College education; age, 23. Address H. I. S., Box 160, Frankfort, Ross Co., O. 7-6t

WANTED—Position by a competent and energetic young man with three years' experience in city and railway engineering. First class with instruments and a good draftsman. Small salary. A1 reference. Address J. K. A., care of ENGINEERING NEWS. 11-3t

WANTED—Position on construction. Hydraulic work preferred; am competent to take charge of work. Good experience and first class references. A permanent position will be an object as well as salary. E. N. P., care Engineering News. 11-3t

WANTED—Situation by an engineer, aged 33. Railroad work preferred. Have instrumental outfit for both office and field. Neat and rapid draftsman. J. F. HUNT, 67 Sigourney St., Hartford, Conn. 11-3t

WANTED.—Young man, 27 years of age, six years' experience, at present employed on M. W. P. R. R., would like to change. Am well acquainted with transit, level and track work. Address M. W., care Engineering News. 11-3t

WANTED—A position as rodman, levelman or transitman by a young graduate in civil engineering. Will go anywhere in North or South America. Either temporarary or permanent employment desired. H. P. SIMPSON, Tuskegee, Ala. 11-3t

WATER FRANCHISE WANTED.

Town not smaller than 2,500; will pay fair price for a franchise that is right where town is promising. Give full particulars. Address "WELDON," care Engineering News. 12-4t

WANTED—Position as assistant superintendent or manager in or near New York; large experience in marine work, steam and hydraulic engineering, 6 years' shop and 10 years' office experience. Has had charge of office before. In good position now. Has been in position in Scotland and Germany. Best references. Address H. K., care ENGINEERING NEWS. 12-6t

WANTED—A steady position as locomotive engineer on some new road. Single; age, 23; three years' practical experience in railroad work; familiar with air and vacuum brakes; graduate of Mech. Engr. Dept. of Minn. State University; good mechanical draftsman and willing to go anywhere in United States. Address A. H. A., 68 Summit Ave., St. Paul, Minn. 12-6t

WANTED—A position as foreman of granite yard, quarry or masonry work; 15 years' experience; reference furnished if desired. Address J. MORRISON, 87 Oak St., Lawrence, Mass. 12-3t

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